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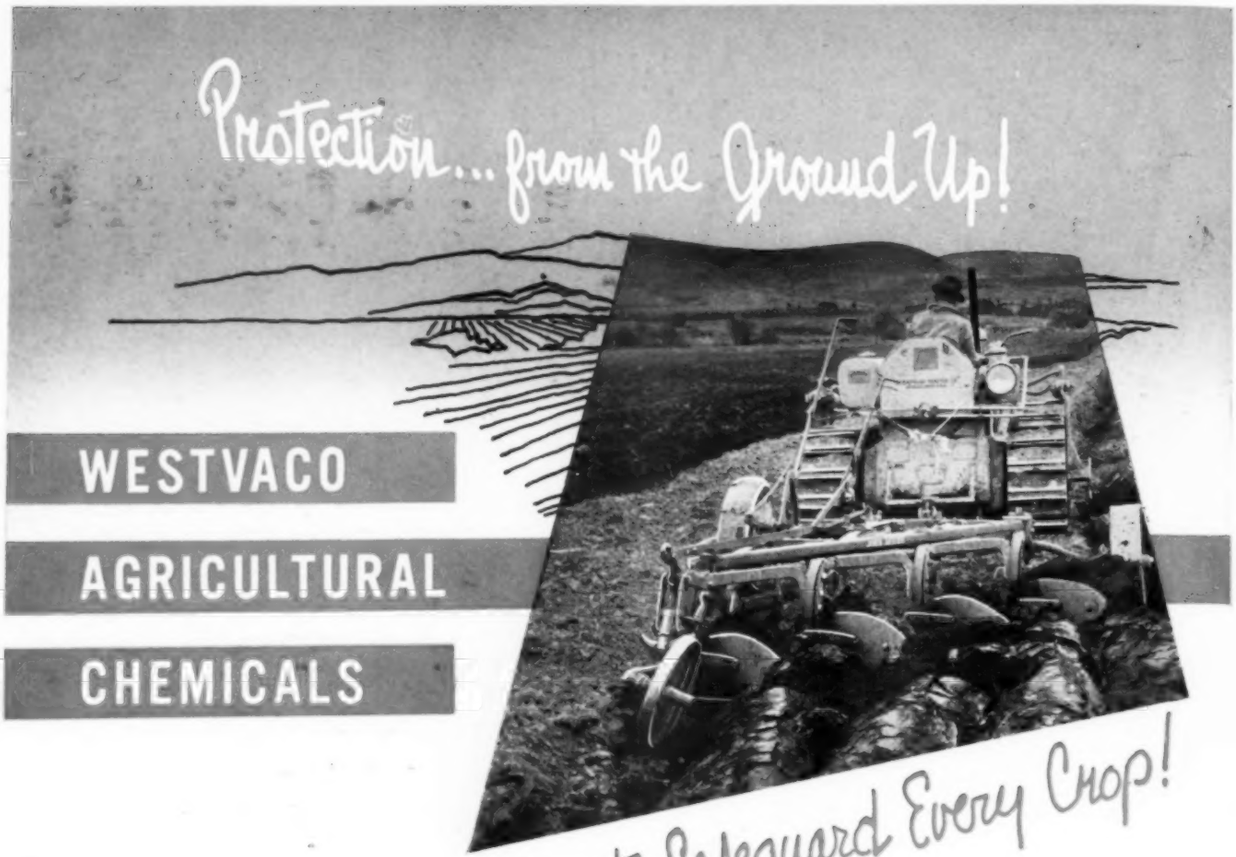
Volume II September, 1947 Number 9



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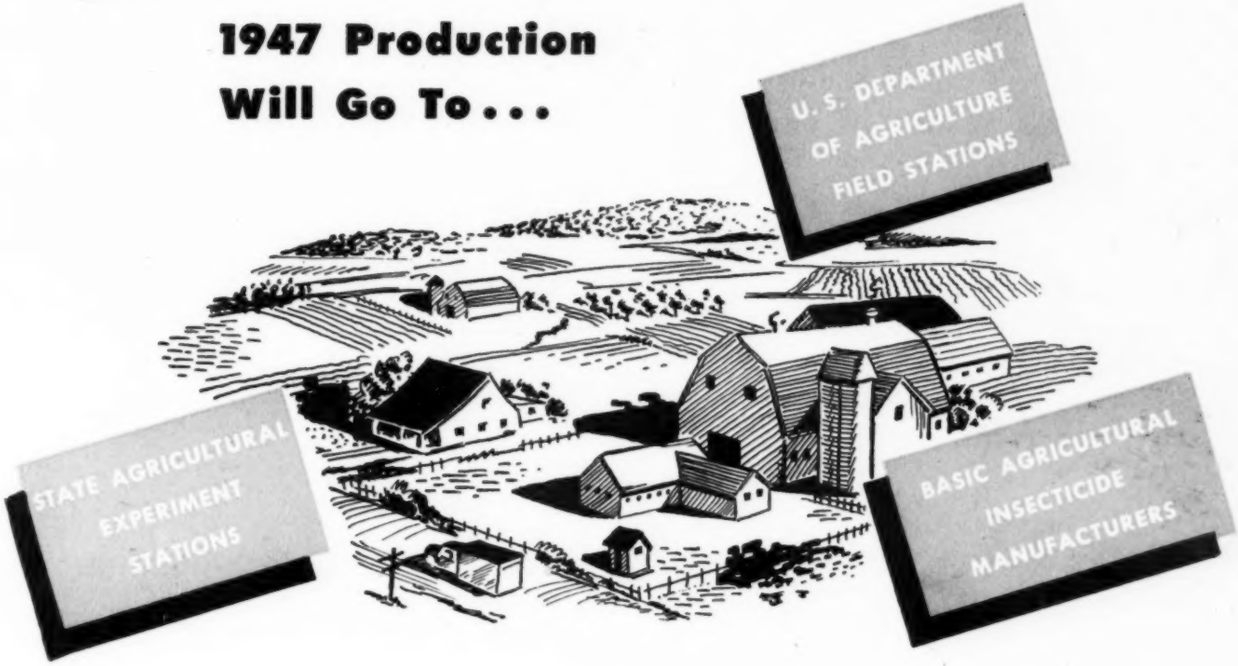
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THIS MONTH'S COVER

This mine scene at Attapulgus, Georgia, shows the initial steps in producing insecticide carriers for the industry. Black and white photo fails to reveal sharp color contrast between dark top earth and valuable clay beneath. This mine is but one of several operated by Attapulgus Clay Co., Philadelphia. (Photo courtesy Attapulgus Clay Co.)

SEPTEMBER 1947
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AGRICULTURAL CHEMICALS

Subscription Rates: *One year* $3.00, *two years* $5.00. *Outside U. S. one year,* $4.00. *Published monthly on the 15th by Industry Publications, Inc. Office of Publication, 123 Market Place, Baltimore 2, Md. Advertising and editorial office, 254 W. 31st St., New York, 1, N. Y. Advertising rates made known on application. Closing date for copy—25th of the month previous to date of issue.*

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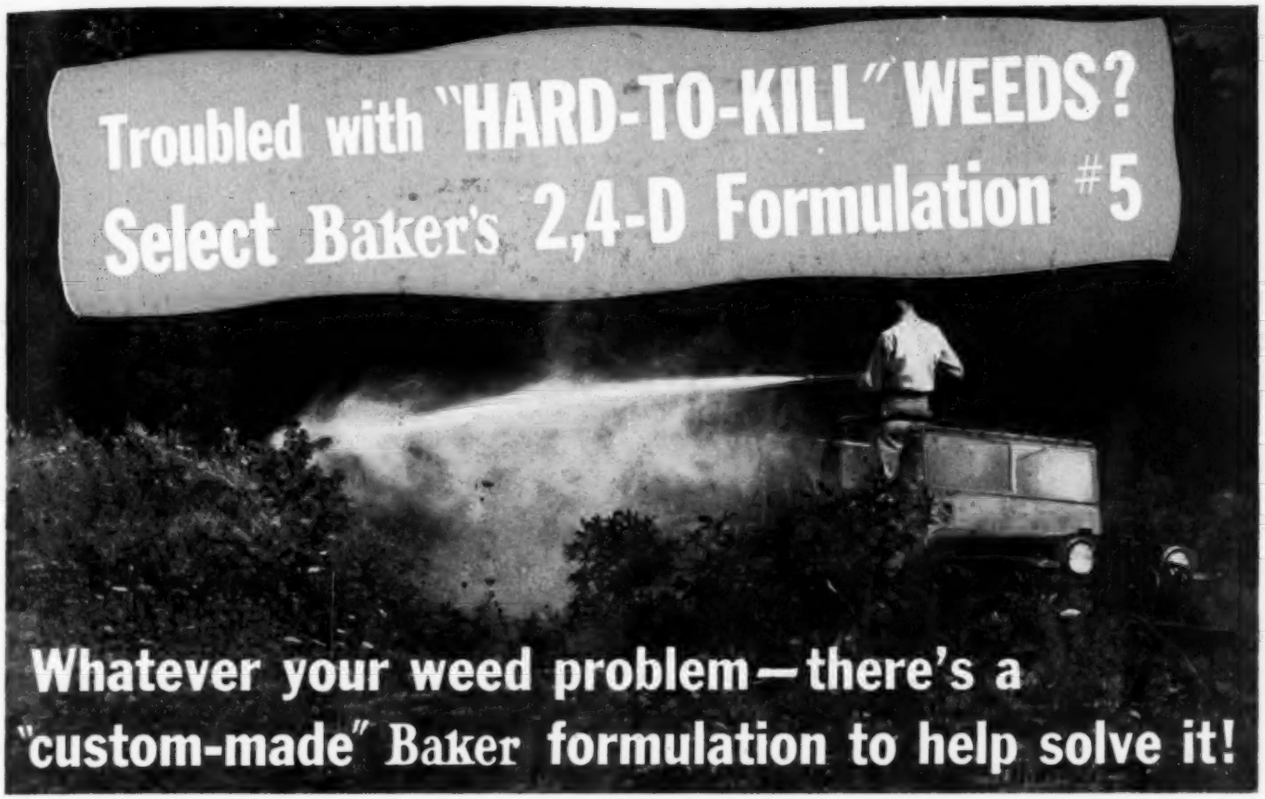
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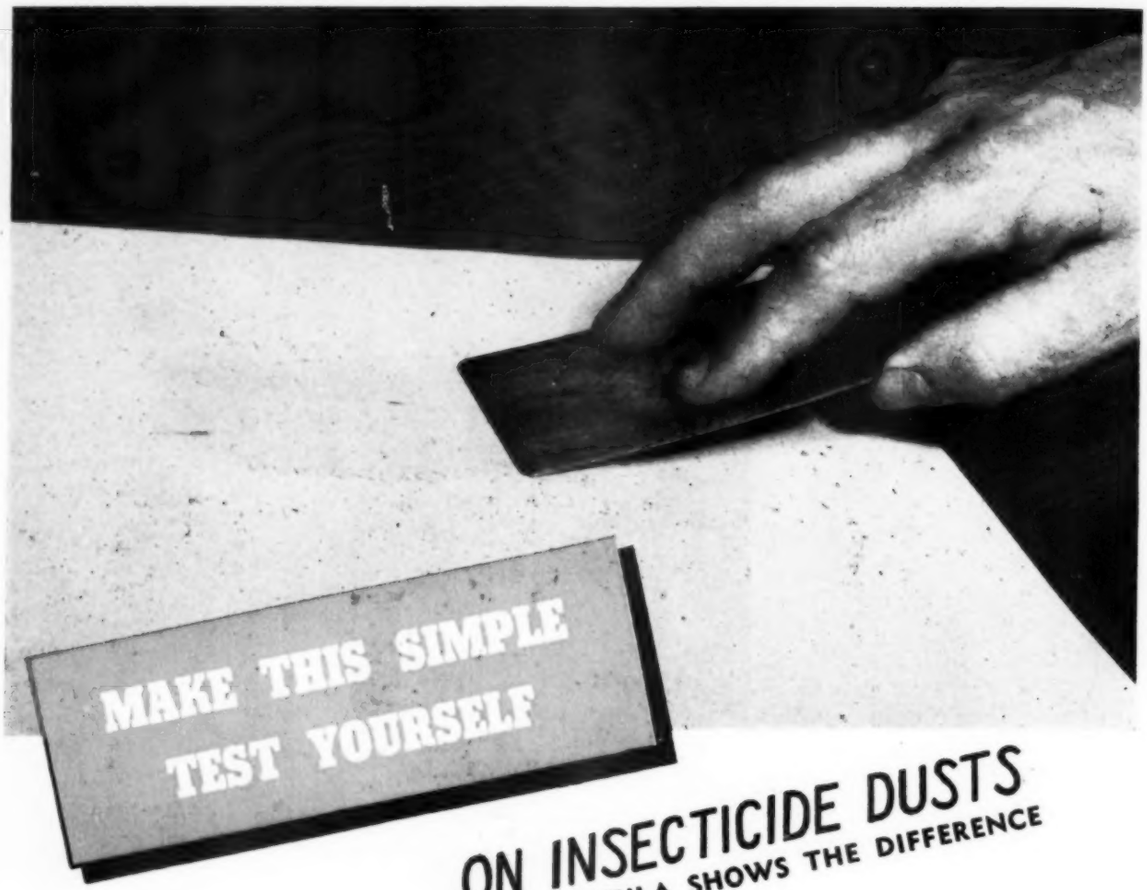

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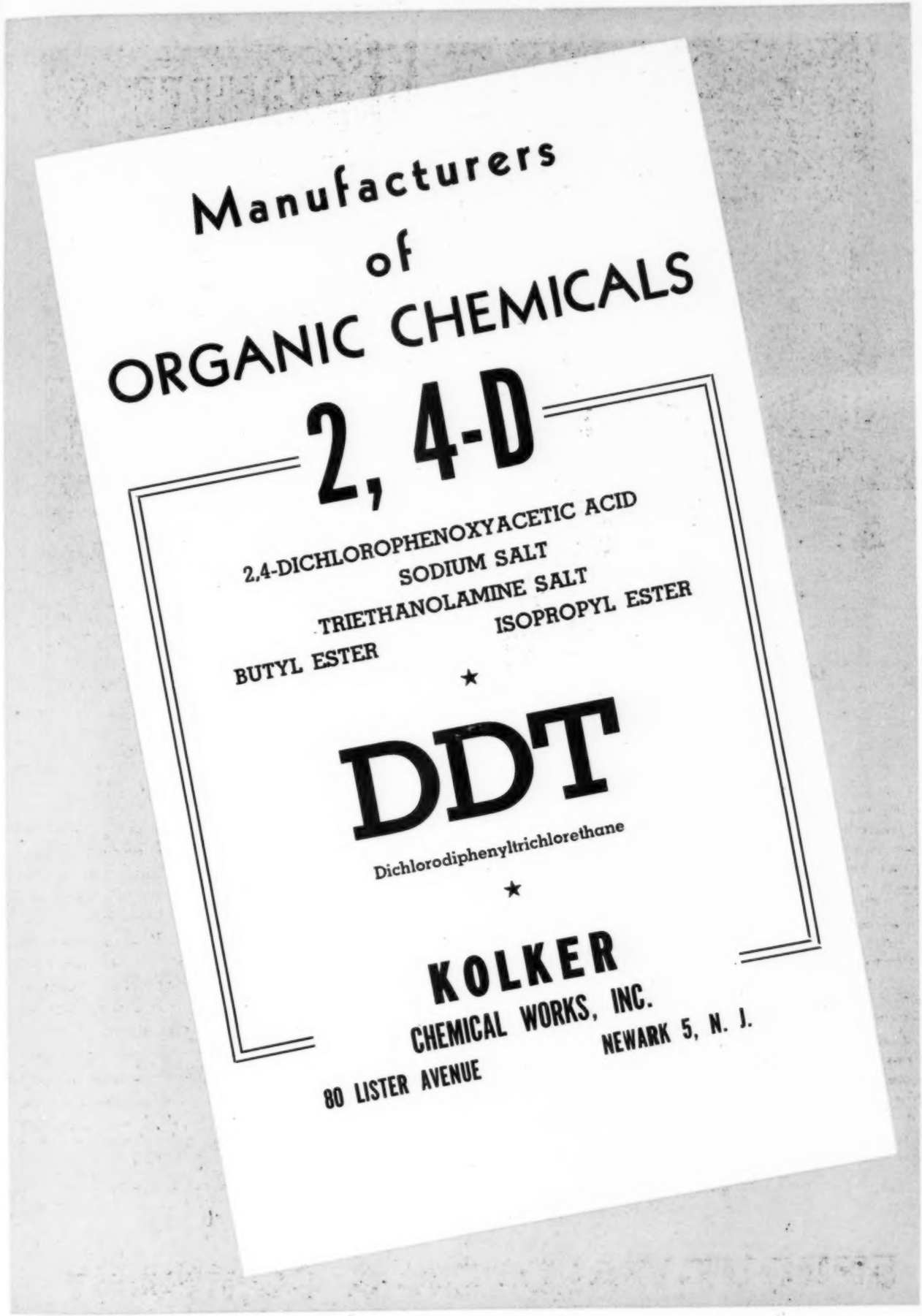
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THE EDITOR COMMENTS

SINCE the founding of their industry many years ago, professional pest control operators, — that is the exterminators and fumigators as they used to be commonly called, — have confined their work mostly to household and industrial insects and rodents. Few have been those who went afield for orchard, crop, and ornamental tree work as custom sprayers. The reasons were several. They enjoyed ample business by specializing in factory, institution, and household indoor bug control. They were not familiar with the pest problems of agriculture, the materials used for their control, nor did they have the equipment for the purpose. The field was left to those specializing in custom spraying and to the tree surgeons.

But times are changing. Household, institutional and industrial pest control appears to be steadily tapering off. To the prolonged efficacy of certain newer chemical insecticides, notably the residual action of DDT, this decline in business is laid. Indoor pest control operators literally have been putting themselves out of business by the effectiveness of their work over the past few years. They are beginning to look to other fields of which agricultural custom spraying and large-scale industrial fungus and insect control are mostly mentioned. And they may in the not too distant future be forced to expand the horizon of their activities in this direction or go out of business.

These changing conditions pose a problem not only for those looking to enter the agricultural pest control field, but for those custom sprayers, co-ops, tree surgeons, and others already in the field. Only by materially expanding the range of all operations, by selling the idea of pest control in a bigger way, can the effects of new competition fail to hurt. If past performance is a criterion, the trade association of the indoor pest control operators, a virile outfit with strong, sensible leadership, will help to broaden the field for everybody in it, old and new alike. We feel that old-time service spraying outfits in the agricultural field stand to benefit, not lose, in the long run if any such invasion of their field ever comes.

DDT producers are currently reported to be up to their necks in DDT—a not surprising situation in view of the tremendous public interest roused by this most important of war time developed insecticides, and the speed with which producers increased capacity as soon as construction controls were relaxed. Plants now operating are said to be capable of turning out one hundred million pounds of DDT a year, with several more new producers scheduled to go into production, and to add further to excess productive capacity, before the end of the year.

Faced by this situation, the recent price reduction has been more or less indicated for some time, and the probability would seem to be that before this situation shakes itself down thoroughly there will be fewer producers than the approximately fifteen companies now making DDT. There seems definitely to be no domestic market for one hundred million pounds of DDT, or anything like that amount, and export demand apparently cannot be expected to solve the producers' problem at any early date. This situation is analyzed at greater length in a review of the subject in this issue (See Page 43) which offers a number of predictions as to what the future course of the market for DDT and DDT insecticides may be.

A BAN on loading or unloading ammonium nitrate in populated areas except by the Army has been issued by the U. S. Coast Guard. The Army has also issued new and strict regulations for the handling of this fertilizer chemical. No ship carrying ammonium nitrate may carry sulfur or explosives at the same time, and no other

cargo may occupy the same hold where the nitrate is stored. In New York last month, two ships with ammonium nitrate cargoes were ordered to leave port and the port was closed to ships carrying this material until new regulations might be issued. West Coast cities have added or proposed to add new restrictions on storage and shipment of ammonium nitrate, other nitrates and several hundred additional chemicals. In Congress, a bill was introduced to study the fire and explosion hazard of fertilizers and other agricultural chemicals.

That close scrutiny and restrictive activity by public officials would follow the disastrous fires and explosions at Texas City, Texas, and Brest, France, had been anticipated since these accidents occurred. But the complications in this wave of restrictions go beyond the question of public safety. The matters of insurance, freight, and storage rates, as well as longshoremen's wage rates, are involved in the degree of hazard presented by ammonium nitrate. As an explosive, as contrasted to an inflammable substance, the cost of loading and shipping the nitrate might seriously interfere with the export of the chemical,—might conceivably stymie the Army's export fertilizer program.

As mentioned previously, we sincerely hope that a wave of local regulations affecting all chemicals will not follow in the wake of these ammonium nitrate restrictions. Recent activity on the West Coast and in Washington could be the forerunner of such action which might entangle all fertilizers and other agricultural chemicals in a webb of red tape and still further increase costs to the ultimate consumer.

—•—

THE tentative regulations for enforcement of the new Federal Insecticide, Fungicide and Rodenticide Act, which were released for study by interested parties early last month, were scheduled to be discussed in open hearings at Washington on August 25th. As this issue of AGRICULTURAL CHEMICALS closed for the press, there were indications that manufacturers of the products affected would present a number of suggestions for changes in the proposed regulations, which after all was the purpose of the Department of Agriculture in releasing the regulations for study, and asking for industry comment and criticism at the open hearing.

Clarification of some sections of the regulations seems to be generally called for, particularly the sections relating to handling of experimental materials. Some objection has also been raised to the rather involved set of four warning signals, "POISON," "DANGER," "WARNING" and "CAUTION," set up in the first tentative draft of the new regulations.

In drafting the act itself, the department showed a commendable willingness to give due attention to the problems of insecticide manufacturers in achieving a sensible and workable measure, while still preserving the required degree of protection for users of the controlled materials and the public at large. There seemed no reason to believe that this same attitude on the part of department officials would not characterize the hearings on the regulations for enforcement of the act.

—•—

WHEN we check the requirements of new firms entering the spraying and dusting fields of agriculture, the knowledge and equipment needed, a vision of hopping aboard the Broadway Limited in full flight comes to mind. Progress of recent years has been so great, new things, new methods, new equipment have been so many,—and the present rate of progress continues so rapid,—that it becomes a stunt of mental agility merely to keep pace in thought with new developments, let alone with their practical applications. For the USDA, our state departments of agriculture and experiment stations, and our county agents, we should be duly thankful. For otherwise, we would be buried beneath a pile of mixed wheat and chaff, not knowing one from the other. But even with their help, the burden on any new firm is heavy, their responsibility great, and their knowledge limited. All this is something to be borne in mind by those who may have thoughts of branching out into the agricultural pest control field.

Guest Editorial written especially for this issue of Agricultural Chemicals.

Larger Use of Chemicals by Agriculture Forseen

by

George F. Leonard

President, Agricultural Insecticide and Fungicide Association

THE efficiency of American agricultural production is certain to be substantially increased in the years ahead by the fuller and more effective use of pesticides. This augurs well for the future of the agricultural insecticide and fungicide industry, whose fortunes are inseparably linked with the economic welfare of the nation's farm plant. Such a development is inevitable because our farmers, more efficient than those of any other land, are stepping up their application of industry's materials in the production of food, fibre, fats and oils.

Introduction of new organic chemicals has accelerated the trend of many years in the increasing and broadening use of insecticides, fungicides and related materials. With high farm prices in recent years more farmers have used more products of our industry—and the results of such use, measured in higher yields and improved quality, provide a convincing lesson to the farmer of the value of pest control.

The outlook for the industry is encouraging. Demand for farm products, both at home and abroad, promises to continue at high levels for several years. Downward revision in some farm prices is to be expected and some have already declined. In this situation, sound merchandising by industry will impress upon the farmer the fact that the effects of declining prices can be minimized by using pesticides which increase yield and improve quality.

Now, as never before, the manufacturer must adjust himself to rapidly changing conditions caused by the continuing development of new materials, expanding fields of use, and increased world demands. The record clearly shows, in this industry as in America's free enterprise system generally, that the spur of competition has improved existing products and developed new ones, widened and streamlined distribution, and in many other ways benefitted the consumer.

It follows that the manu-

(Continued on Page 59)

THE recent appearance of several new volatile chemicals, together with the fact that they can be economically applied to large acreages for the control of soil infesting insects, nematodes, weeds, weed seeds, or fungus organisms has given a tremendous impetus to the use of this method of treatment. Since 1944 approximately 53,000 acres of soil in the United States have been treated with the new fumigants "DD" and "EDB," in addition to some 25,000 acres in Hawaii.

The use of volatile chemicals for treatment of soil is not an innovation. Baron Thénard in 1872 used carbon disulphide to control phylloxera in France and since this time carbon disulphide has been more widely used in field and laboratory tests than any other soil fumigant. Its use for weed control is outlined in a recent bulletin by Hanneson, Raynor and Crafts (1945).[1] For root knot nematode control it has been used at the rate of 500 to 1000 pounds per acre, or 8.25 ml. per square foot. Chloropicrin came into use after World War I and has been used extensively for the control of nematodes at the rate of 200 to 600 pounds per acre, or as spot treatments at the rate of 2 to 4 ml. at 10 to 12 inch centers. Phenol, cresol, creosote, coal tar distillates and naphthalene have all been used for soil treatment. Paradichlorobenzene was used by Howard in 1918 for the control of the woolly apple aphis on nursery stock. The cyanides, particularly calcium cyanide have been used since 1924. Campbell[2] in 1924 used granular calcium cyanide applied to a trap crop for the control of wireworms and this method has been used quite extensively in California. Beta betá dichlorethyl ether has been used as a soil fumigant following some work by Lehman in 1933. A rather complete review of soil insecticides; including non-volatile types can be found in a recent paper by Gough (1945).[3] A review of volatile soil fumigants as they pertain to plant diseases can be found in an article by Newhall (1946).[4]

Above—Wireworm control. Todd Ranch, Oxnard, Ventura County. Field treated April, 1945, 30 gallons of 5 per cent ethylene dibromide per acre. Diagonal streak is untreated and background untreated. (Courtesy of Dow Chemical Company.

Before discussing some of the newer soil fumigants it might be advantageous to bring out a few generalizations which have determined the effectiveness of other chemicals. Soil fumigation treatments do not always give results and plant response any more than the application of proven insecticides to insects above ground always gives good results. The comparative higher costs of soil treatment as compared to treatment above ground, however, makes it necessary to minimize failures.

Newhall (1946)[4] gives the qualifications of an ideal fumigant as follows:

1. **It should kill a variety of micro-organisms, insects and weed seeds.**
2. **Should be inexpensive and non-inflammable.**
3. **Should be easy to handle and harmless to the operator and equipment employed.**

by

W. Harry Lange

University of California, Davis

4. **It should be quick to penetrate and do its work, both deeply and on the surface layers yet leave the soil or be harmless to subsequent plant growth.**
5. **Should not be as phytocidal as to be harmful to living plants nearby.**

The limiting factor in the use of a soil fumigant for large scale agricultural purposes is the cost of the chemical provided it can accomplish the job for which it is intended and can be economically applied.

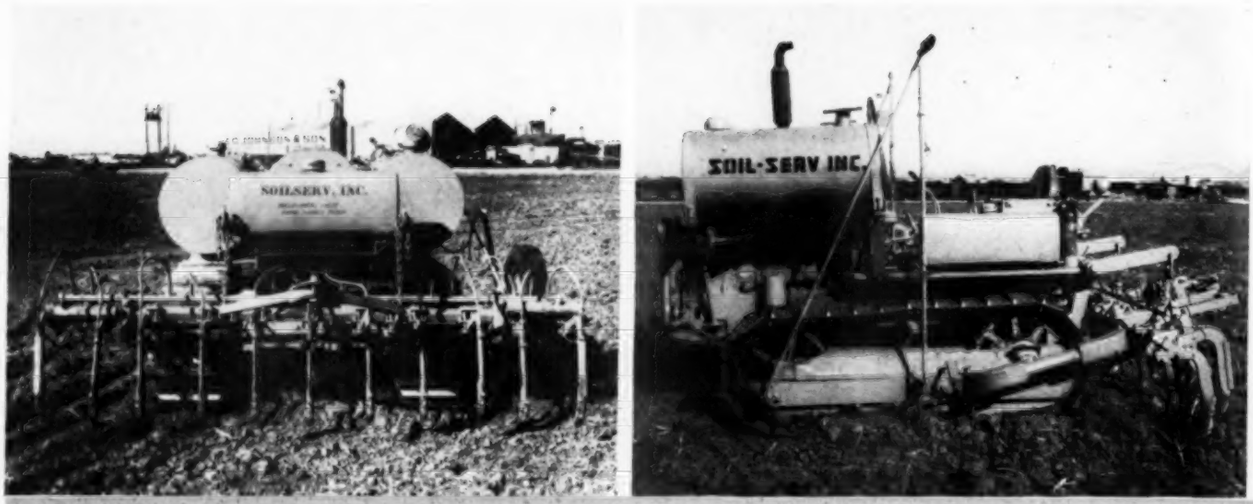
It was soon observed that in the field using DD mixture and ethylene dibromide that the crop response as expressed in rate of growth and subsequent plant yields was greater than would be expected on the basis of the kill of the insects alone. The effects of partial soil sterilization have been observed with a number of fumigants, notably with chloropicrin and carbon disulphide. These effects were noted in the 1890's by Girard and Oberlin, and later it was found that heat treatment gave the same results. The effects of different soil fumigants on the soil is not fully known, but a few of the reasons for crop stimulation and response following their use include an effect on the chemical and physical properties of the soil, particularly a change in soluble soil constituents; some effect on soil fertility, such as an increase in the ammonia content of the soil; and an increase in the bacteria of the soil due to the killing of harmful Protozoa. A further discussion can be found by referring to Martin.[5]

In addition to the effects of partial sterilization increased yields following the use of certain volatile chemicals are due to the restoring of a more favorable biotic complex, such as the reduction in numbers of certain insects or nematodes. Having this more favorable condition the plants are able to make a better root growth and utilize more fully the available soil nutrients.

The results of soil tests are so variable that it might be well to mention the factors which determine the effectiveness of soil fumigation under a particular set of conditions. These factors include soil temperature, soil type, soil texture, adsorption, composition, compactness, and soil moisture, amount of fumigant used, correlation of time of treatment with the known behavior of the organism to be killed, the type of seal used following treatment, and other factors.

Soil temperature affects diffusion, volatilization of the fumigant, biological processes, and susceptibility of the insects (see Gough[3]). Soil type, texture and compactness affect the physical processes. Thorne (1939)[6] found that the presence of a plow sole determined the degree of penetration of hydrocyanic acid gas.

Results of fumigation with ethylene dibromide in Ventura County, California. On left untreated; right, treated with 1 gallon of ethylene dibromide per acre for wireworm control (Fordhook lima beans) Population in checks 45 worms per 3 feet of row. (Courtesy of Dow Chemical Company.)



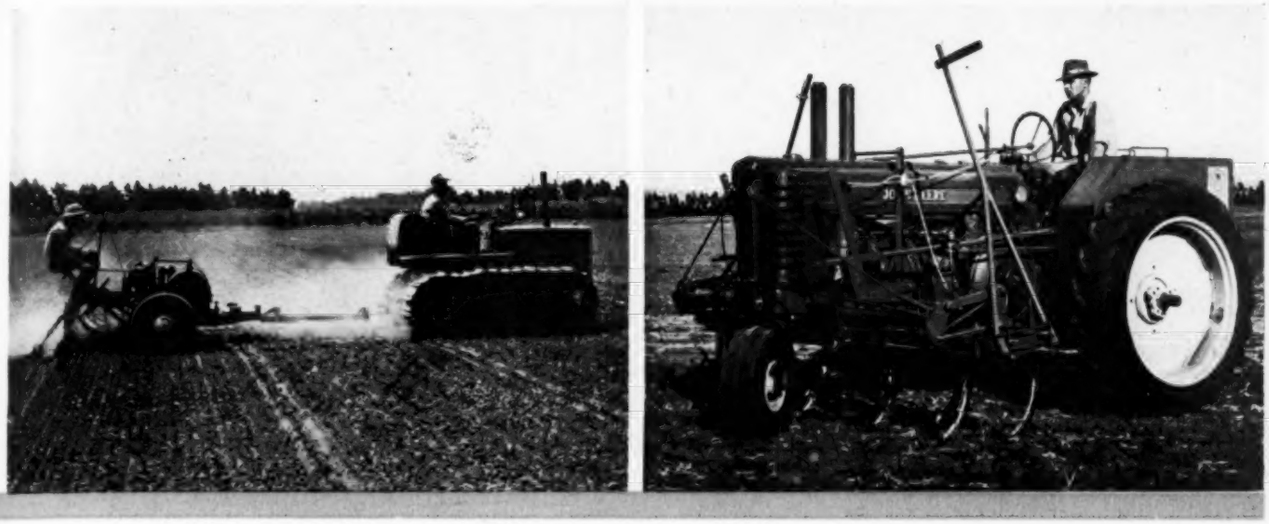
Left: rear view of caterpillar-type applicator, showing how insecticide material flows into small furroughs cut by machine. Right: side view of same apparatus.

Stark (1945)[7] found that the amount of gas absorbed on any soil is largely dependent upon the amount of the clay fraction. With chloropicrin he found that the higher the clay fraction the better chance the plant had for survival. He found the amount of adsorption related to the boiling points of the chemicals—a greater adsorption with increased boiling point. Crafts and Cakin (1947)[8] in comparing carbon disulphide, carbon tetrachloride, tetrachloroethane, ethylene dibromide, and dichloropropane-dichloropropene mixture found wide differences in the adsorption of these chemicals to soil particles. They found ethylene dibromide more highly adsorbed than the others followed in order of decreasing sorption by tetrachloroethane, dichloropropane-dichloropropene, carbon tetrachloride, and carbon disulphide. This degree of sorption correlates with the molecular weights of the fumigants. It is also interesting to note that ethylene dibromide is used at 27 to 36 pounds per acre and carbon disulphide at 1,000 to 3,000 pounds per acre. The importance of soil moisture under field conditions to penetration of a gas is not fully known. A high water content, up to field capacity, decreases the amount of adsorption and theoretically does not interfere with the penetration of a gas in a soil having natural structure, in fact it should enchance penetration. Certain soil fumigants require surface seals in order to be effective, an example being methyl bromide. The cost of a water or paper seal would limit the use of certain fumigants for general agricultural use.

"DD" Mixture

The work of Carter in the Hawaiian Islands using "DD" mixture for the control of injurious organisms in pineapple field was initiated in 1940 and reported in several articles (1943,[9] [10] (1945). The low cost of the fumigant and the promising results initiated research in the United States along the lines of halogens in various chlorinated and bromated hydrocarbon compounds. The early research with "DD" and other materials on nematodes, pathogenic fungi and bacteria, insects and weeds and growing plants is contained in two confidenital reports compiled by committees representing the United States Department of Agriculture, Agricultural Research Administration in cooperation with the Association of Land Grant Colleges.

"DD" is a dark liquid containing 1,2-dichloropropane and 1-3-dichloropropene and minor percentages of other lighter and heavier hydrocarbons, saturated and unsaturated. Stone (1944)[11] reported it effective for wireworm control when used in emulsion form and Lange (1945)[12] reported its use at the rate of 400 pounds per acre applied by field applicators. "DD" has been found effective on wireworms when applied to a depth of 6 to 8 inches with a 12 to 15 inch spacing. There is some evidence of carry-over to two years in one series of experiments and in another series no carry-over to a third year was found. In one "experiment "DD" was found more effective than dichlorethylether, calcium cyanide and crude naphthalene flakes. In certain instances particularly with spring lettuce the addition of 35 to 70 pounds of ammonia with the "DD" as a fall treatment gave substantial increases in yields, but in other instances no increases were obtained. Subsequent crop yields do not always increase with the use of increased amounts of the fumigant. Although 200 pounds of "DD" have averaged 75 per cent control of wireworms over the past 3 years under different conditions, the yields obtained from this amount of fumigant may in some cases be as high as those obtained with 400 to 600 pound treatments.) This will depend primarily upon the population of wireworms present. High populations such as 25% might cause considerable damage, or it might depend on the activity of wireworms at the time of the test. During 1945 comparative tests with EDB were made. Recent experiments have indicated some value in the combination of DD and EDB, but further testing is needed. Work so far on DD has indicated that it is not as greatly affected by soil moisture and temperature as are certain other soil fumigants. On the other hand it is often retained in the soil for con-



Left: trailer applicator for distributing ethylene dibromide. Right: tractor equipped for application of soil insecticides, an example of self-propelled applicator.

siderable periods and long intervals of time are necessary under certain conditions before crops can be safely planted. Bean and sugar beet seed have been killed when planted 10 to 12 days after treatment and certain root vegetables may take up the odor of "DD" if planted too soon after treatment. The period of toxicity varies, but "DD" often remains toxic to wireworms for a week following treatment. Work on nematodes with "DD" has indicated that it has definite promise although different investigators differ in regard to dosage due undoubtedly to the different conditions under which the tests are made and the different nematodes involved. Paris (1945) (see Newhall)[4] obtained good control with 200 to 400 pounds of "DD" per acre, but obtained no control of damping off organisms or weeds. Newhall (1946) states that 500 to 700 pound per acre is necessary for nematodes. On the sugar beet nematode substantial increases of beets per acre are obtained with 200 to 300 pounds per acre.

Ethylene Dibromide

Ethylene dibromide has been developed primarily for the control of wireworms, although it also has value in the control of other soil inhabiting insects and nematodes. A dosage of 2 gallons of EDB per acre in a naphtha base (using 20 gallons of total material) has proven effective on wireworms although in some cases as low as 1 gallon or as high as 4 may be necessary. This material is less phytocidal than "DD" as beans and corn can be planted the same day of treatment, and under certain cases it can be applied to living plants. Tests would indicate a narrower diffusion range than with "DD" and for this reason a spacing of 12 inches is recommended. The soil should not be too dry or too wet and although a water seal is not necessary, a drag or roller is often of value. For nematodes Christie (1945)[13] reports good results in some lateral diffusion tests using the root knot nematode. EDB compared favorably with chloropicrin, "DD," a 10 per cent methyl bromide solution, and 1,1,2-trichloroethane.

In addition to "DD" mixture and ethylene dibromide which have received a great deal of attention a number of other materials should be mentioned although no attempt will be made to give a complete list of new chemicals which show promise.

Propylene Dichloride

This ingredient of "DD" mixture has been known for a number of years, in fact Bowen and Haller (1945)[14] report it as being tested 20 years ago. Snapp (1945)[15] reports a propylene dichloride emulsion for control of the peachtree borer which is more effective at low temperatures and gives less tree injury. This chemical is reported as having no nematocidal properties.

Ethylene Dichloride

This material has been used for control of the peach tree borer, for nematode control and recently has been used as an emulsion with ethylene dibromide for the fumigation of Japanese beetle larvae in the soil by Chisholm and Koblitsky (1946)[16]. The formula used is ethylene dibromide 16 per cent, ethylene dichloride 81.5 per cent, and *Tween* 20, 2.5 per cent (all by weight). For nematode control it takes 2,000 pounds of ethylene dichloride, but various mixtures have been made with chloropicrin which gives control at intermediate costs.

Methyl Bromide

The low boiling point of this chemical, 4.6°C., has made it difficult to handle in the soil. For this reason it has been added to solvents such as xylol. "*Dowfume* G" is a 3 to 1 mixture of ethylene chloride, and carbon tetrachloride, plus 10 per cent methyl bromide. A 15 per cent mixture in xylol is called *Iscobrome*. Methyl bromide has been used chiefly in greenhouse work in cases where an adequate water seal or paper seal can be used.

Hexachlorocyclohexane

This chemical is one of the most promising of the newer chemicals for the control of wireworms and other soil inhabiting insects. The British have pioneered the field in its use for wireworm control. Slade

(*Turn to Page* 68)

A.I.F.A. Holds 14th Meeting at Spring

DISCUSSIONS centering around the new insecticide act; labeling problems; the Robinson-Patman amendment to the Clayton act; relationships of agriculture, government and industry; and problems pertaining to new insecticides were scheduled for the 14th annual convention of the Agricultural Insecticide and Fungicide Association. The meeting covering three days, September 2, 3 and 4, was held at the Essex and Sussex hotel, Spring Lake, N. J.

In addition to the committee reports and presentation of various papers, the association held its annual election of directors, and showed a number of moving pictures produced by manufacturers of insecticidal materials and application equipment.

Wednesday's session was called to order by A.I.F. Association president George F. Leonard of Tobacco By-Products & Chemical Corp., Louisville, Ky. Following Mr. Leonard was Lea S. Hitchner, executive secretary and treasurer of the association, who presented his annual report. Dr. P. N. Annand, chief of the Bureau of Entomology and Plant Quarantine, U.S.D.A., Washington, D. C., addressed the group on "Problems Related to the General Use of New Insecticides."

Dr. George C. Decker, entomologist of the Illinois Natural History Survey, Urbana, Ill., described the latest methods being used in control of the corn borer which is extending its invasion more deeply into the midwestern corn belt. Dr. Decker's report was based on data secured but a few days before the AIF meeting date.

The new Federal Insecticide, Fungicide and Rodenticide act of 1947 was discussed in detail by Harry Reed, chief, Livestock Branch, Production and Marketing Administration of the U.S.D.A. He was followed by Dr. W. G. Reed, chief, Insecticide Division of the Livestock Branch, Production and Marketing Administration, U.S.D.A.

The report of the AIF Legislative Committee was made by W. W. Sunderland, chairman, who described the important changes in the legislative situation within the past months.

An industry forum, led by Wallace S. Moreland of Rutgers University was held, with lively discussion on many problems facing the industry presently. Appearing on the forum program in addition to Mr. Moreland were Russell B. Stoddard of Dodge & Olcott, Inc., New York; Ernest Hart of Niagara Chem-

Harry Babcock
Describes Clayton Act Amendment

George C. Decker
Explains Corn Borer Control

Maurice H. Lockwood
Tells of Gov't.-Industry Relations

ANNUAL LAKE

Spring Lake meeting brings together top men in fields of legislation, technology, research, and industry to discuss problems facing the insecticide, weed killer, fungicide and fertilizer trade in the U. S.

ical Division of Food Machinery Corporation, Middleport, N. Y.; and P. J. McManus of Cooperative G.L.F. Soil Building Service, Inc.

The meeting was then adjourned for the day, the afternoon being devoted to group conferences. In the evening the annual dinner for members, ladies and guests was held.

Thursday's session was again opened by president George F. Leonard, following which R. B. Stoddard presented the annual report of the Membership and Information Committee, of which he is chairman. An address by Maurice H. Lockwood, president of the National Fertilizer Association, Washington, D. C., followed. Mr. Lockwood's topic covered "Agriculture, Government and Industry Relationships."

The annual report of the Traffic Committee was presented by chairman E. C. McClintic, of Pure Carbonic, Inc., New York. Dr. Charles L. Smith, technical advisor of the AIF Association presented an over-all picture of "Industry Labeling Practices." Harry Babcock of the Federal Trade Commission, Washington, D. C., presented a comprehensive discussion on "The Robinson-Patman Amendment to Section 2 of the Clayton Act, and Federal Trade Commission Cooperation with the United States Department of Agriculture in enforcement of the new Federal Insecticide, Fungicide and Rodenticide Act."

Dr. Gordon L. Utter, Phelps-Dodge Refining Corp., New York, presented the report of the technical committee, of which he is chairman. He pointed out results of technological studies and emphasized the need for continued analytical work.

Report of the Joint Committee on Application Equipment was given by Jack Vernon, of Niagara Sprayer Division, Middleport, N. Y. This new committee is composed of Dr. Charles L. Smith of the A.I.F. Association, Frank Irons of the U. S. Department of Agriculture, W. W. Tranter of A. B. Farquhar Co., York, Pa., and Mr. Vernon. (Additional members were to be named at a later date.) The committee reported having made progress in studying various mechanical devices for the application of insecticides, fungicides and chemical weed killers, but that new problems are arising from the introduction of new synthetic materials which require special equipment for efficient distribution.

The afternoon session of Thursday was devoted to a meeting of the A.I.F. board of directors.

W. G. Reed

Chief, Insecticide Div., Livestock Branch, U. S. Dept. of Agriculture

P. N. Annand

Discusses New Insecticides

L. S. Hitchner

Presents Association's Annual Report

INSECTICIDE PROBLEMS

MORE synthetic organic compounds with outstanding insecticidal properties have been discovered within the past five years than in all the previous years in which systematic research on insecticides has been carried out. Several of these discoveries came at a time when the demand for insecticides was greater than ever before and when the available supplies were exceptionally low. To some it may appear that the findings are due to hastily initiated wartime research and are largely fortuitous. This is not the case, however. Rather, the discoveries are the culmination of extensive explorations over a period of about 80 years. Chemicals have been used for a longer time to combat injurious insect pests, but it is only since about 1867 that systematic study to find new insecticides has been under way.

The early studies concerned themselves largely with inorganic compounds, such as paris green and lead arsenate. About 1910, agricultural practices became more intensified and insect populations increased, as did the losses which they caused to many important crops. About the same time investigators became interested in finding out how insecticides kill and emphasized the importance of physical characteristics, such as wetting and spreading of sprays on foliage and insects. A few years later studies were initiated to determine the structures of the highly effective, naturally occurring insecticides, the pyrethrins and rotenone. These studies proved fruitful, and the structural formulas that were developed served as patterns for the preparation of organic compounds thought to be toxic to injurious insects. These studies were supplemented by the testing of a large number of synthetic organic compounds that became available soon after the first World War and for which a use was being sought. The two approaches have been profitable and have led to the discovery of a number of compounds highly toxic to insect pests.

The knowledge that an organic compound is highly toxic to a number of species of insects is not the only requirement for its immediate wide-scale use. Before its utility in controlling injurious insects can be determined, information must be obtained as to its safety to public health, to soils, to vegetation, to farm animals, to benecial insects including bees, and to wildlife wherever these interests are involved. It is necessary to know the range of effectiveness—that is, to what kinds of insects the product is toxic; the stage of the insect that is destroyed (egg, larva, adult); and whether the compounds can best be applied as a dust, spray, or aerosol. Basic to the development of such information, a knowledge of the physical and chemical characteristics of the product is needed. Physical and chemical studies should include determination of its composition, its solubility in various solvents,

Table II
Hydrolyzable Chlorine of Some Chlorinated Hydrocarbons Having Insecticidal Value

Compound	Number of Chlorine Atoms Removed	Per Cent of Chlorine Removed	Ratio Hydrolyzable Chlorine to Total Chlorine
DDT	1	10.0	1:5
TDE	1	11.08	1:4
DMDT	1	10.33	1:3
Benzene hexachloride	3	30.57	3:6
Chlordane	*	—	—
Chlorinated camphene	*	—	—

* Quantitative data have not been published; however, it is known that at least one of the chlorine atoms is hydrolyzable; the number depends upon the conditions of hydrolysis, such as concentration of alkali and time of heating.

TABLE I
Formula and Chlorine Content of Some Chlorinated Hydrocarbons Having Insecticidal Value

Product	Formula	Per Cent Chlorine
DDT	$C_{14}H_9Cl_5$	50.01
TDE	$C_{14}H_{10}Cl_4$	44.33
DMDT	$C_{16}H_{15}O_2Cl_3$	30.77
Benzene hexachloride	$C_6H_6Cl_6$	73.15
Chlordane	$C_{10}H_6Cl_6$	69.22
Chlorinated camphene	$C_{10}H_{10}Cl_8$	68.54

By

H. L. Haller*

Agricultural Research Administration,
Bureau of Entomology and Plant Quarantine, U.S.D.A.

TABLE III
Toxicity of the Various Isomers of Benzene Hexachloride to Larvae of Anopheles Quadrimaculatus Say *

Isomer	Dosage	Mortality in	
		24 Hours	48 Hours
	P.p.m.	Per Cent	Per Cent
Alpha	2.5	88	92
Beta	100.	22	40
Gamma	.01	80	100
Delta	2.5	40	62
DDT (check)	.01	98	100
	.005	53	85

* Unpublished data from Orlando, Fla., laboratory, U. S. Bureau of Entomology and plant Quarantine.

and its compatibility with other insecticides, fungicides, and dust diluents. Methods for the analysis of the product itself as well as in dusts, in sprays, and in combination with other insecticides, must be developed. Procedures for determining the product as a spray residue are also needed.

It is not possible at this time to discuss each of these properties for all the newer insecticides. It may be of interest, however, to present briefly some of the problems that confront the chemist in the development of methods for the detection and estimation, by chemical or physical means, of one group of closely related insecticides, that have recently attracted much attention, namely chlorinated hydrocarbons. The more important members of this group are DDT, TDE (also known as DDD), DMDT[1], benzene hexachloride, chlorinated camphene, and chlordane. The technical grades of all six of these products are mixtures of two or more isomeric compounds, the insecticidal value of which varies with the product and the test insect. The empirical formula and the total-chlorine content of each are given in Table I.

In each of these compounds part of the chlorine is labile, or hydrolyzable. By this is meant that under certain conditions some of the chlorine is readily removed as hydrogen chloride, with the formation of a product having a much lower insecticidal value than the original compound or none at all. The reaction is brought about by alkali and in some cases alkaline products, such as lime or calcium arsenate. Traces of certain compounds, known as catalysts, such as ferric chloride or aluminumin chloride, can also induce the reaction with some of the compounds. The extent to which hydrolyzable chlorine is produced by catalysts varies with the compound and the conditions of the experiment. The number of chlorine atoms and the percent of chlorine that is removed by treating the compound with alkali in alcohol solution are seen in Table II.

SEVERAL of the analytical methods that have been proposed for the determination of these chlorinated hydrocarbons are based on the conversion of the organically bound chlorine into water-soluble inorganic chlorides, with subsequent estimation of the latter by standard methods. The results obtained by this procedure are of limited value, as the method is not specific. The determination of the hydrolyzable chlorine has also been proposed as a method for some of the compounds, especially DDT (1, 2). Although the method is not specific for any one of the compounds, it is more valuable than the total-chlorine method, because degradation products are not likely to interfere and, when both methods are used, the ratio of the two can serve a useful purpose, provided it is known that no other chlorinated product was present in the sample.

More experimental work has been done to find analytical methods for DDT (3) than for all other five products combined, probably because DDT was the first of this group to be found valuable as an insecticide. The methods first proposed determined

Table IV
Percentages of Different Isomers in Various Samples of Technical Benzene Hexachloride *

Sample	Alpha	Beta	Gamma	Delta	Epsilon
1	77	15	5	4	0
2	55	14	11	8	3-4
3	70	0	28.5	Trace	Trace
4	28	0	27	10	9
5	79	11	7	3	—
6	71	12	11	3	3

* Determination by F. N. Alquist, Dow Chemical Co., by an infrared spectroscopic method and used with his permission. The samples analyzed were technical grades of benzene hexachloride obtained from various sources during 1946.

[1] *p,p'*-Methoxy analog of DDT. Although this compound contains oxygen, and is therefore not a hydrocarbon, it is included because of its close relation to DDT.

* Delivered at Pacific Slope Branch meeting of American Association of Economic Entomologists, Berkeley, California, June 23-25, 1947.

Table V
Toxicity of Benzene Hexachloride Isomers to Newly Hatched Larvae of the European Corn Borer *

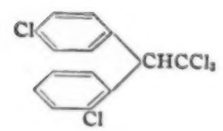
Isomer	Active Ingredient Pounds per 100 Gallons	Mortality Per Cent
Alpha	1	78.9
	0.5	23.3
Beta	4.0	1.9
Gamma	0.125	92.5
	0.063	45.3
Delta	1	95.7
	0.05	0
Alpha+gamma (1:1)	0.063	91.2
Beta+gamma (1:1)	0.063	89.8
Delta+gamma (1:1-	0.063	89.2

* From a report by D. D. Questel and C. V. Bowen. Data presented at the North Central States meeting of the American Association of Economic Entomologists, March 1947.

total chlorine and hydrolyzable chlorine. They were soon followed by several colorimetric methods (4). Although most of the colorimetric methods are much more specific than the chlorine determinations, care must be exercised in their use, as analogs and closely related compounds may produce the same or similar colors.

Chemical studies on the composition of technical DDT (5) showed it to consist essentially of two isomeric compounds, the so-called *p,p'*-DDT and *o,p'*-DDT. Their structural formulas are shown below:

p,p'-DDT



o,p'-DDT

Comparative tests showed the *p,p'-DDT* to be more toxic to a number of insects than the *o,p'-DDT* (6, 7). Efforts were therefore directed to the development of methods which permitted the determination of the *p,p'*-DDT or the amount of each of the two isomers. Cristol et al. (8), developed a useful method for determining the *p,p'*-DDT in the technical product. Essentially the procedure is based on crystallization of the sample from 70-per cent ethanol. The method has not yet been tried with mixtures of the other chlorinated hydrocarbons.

Recently LaClair (9) has published a method for determining *p,p'*-DDT in commercial dusts and oil solutions. The method is based on the findings of Cristol (10) that the *p,p'*-DDT is dehydrohalogenated with alcoholic alkali at room temperature (25°C.), whereas the *o,p'*DDT is only slowly decomposed.

Of the several colorimetric methods that have been proposed for DDT, that of Schechter et al (11, 12, 13) has probably been most widely used. It is based on intensive nitration of the DDT with the formation of a tetranitro derivative. The product obtained with the *p,p'*-isomer gives an intense blue color upon addition of sodium methylate, whereas the *o,p'*-derivative produces a violet-red color. As the method permits the estimation of as little as 10 micrograms, and since none of the degradation or metabolic products of DDT interfere in the determination, it is especially useful for work on spray residues and biological specimens.

A modification of the method that is suitable for determining DDT in fatty materials such as milk, butter, meat, and eggs has been described by Schechter et al. (14). This method is more specific for DDT than any other method proposed. With the exception of TDE, none of the other chlorinated hydrocarbons interfere. TDE gives an almost identical color and therefore DDT cannot be differentiated from it.

Another useful colorimetric method for DDT is that of Stiff and Costillo (15). When DDT is heated in an anhydrous pyridine solution containing xanthydrol and solid potassium hydroxide, a red color develops which is proportional to the quantity of DDT present. The reaction is sensitive to 10 micrograms. As TDE does not give a color with this reagent, Claborn (16) has proposed a method, based on this reaction, for the determination of DDT in the presence of TDE.

TDE is now commercially available, and methods are needed for determining it. Recently Fleck (17) has shown that TDE, when heated with ferric chloride, does not lose one mole of hydrogen chloride, as does DDT with this reagent, but rear-

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Table VI
Average Per Cent Mortality of Confused Flour Beetles Exposed for Various Periods to Benzene Hexachloride 5 Days After it Had Been Applied (1 Mg. of Insecticide to 36 Sq. In. of Surface; 3 Replications)*

Isomer	3 Hours	6 Hours	24 Hours
Gamma	66.6	80.0	100
Delta	20.0	0	0
Alpha	0	0	0
Beta	0	0	0
Gamma+delta (1:1)	3.3	0	43.3
Gamma+alpha (1:1)	0	16.6	43.3
Gamma+beta (1:1)	0	26.6	86.6
Technical benzene hexachloride (15.3 per cent gamma)	26.6	3.3	6.6

* From report presented by R. T. Cotton at the North Central States meeting of the American Association of Economic Entomologist March 1947.

Discuss International Insecticide Use at London Conference

By J. M. Vallance

London Correspondent, Agricultural Chemicals

WORLD-WIDE representation of chemists and technologists attended the Eleventh International Congress of Pure and Applied Chemistry held in London, July 17-24. Although invitations were extended to many U. S. scientists a number had to decline because of transportation difficulties. At least 26 from the States were present, however. Other countries represented included Australia, Canada, New Zealand, South Africa, India, The Netherlands, Belgium, Denmark, France, Italy, Czechoslovakia, Switzerland, Norway, Eire, Yugoslavia, Sweden, Poland, Hungary, Turkey, Finland, Greece, Rumania, Spain, Argentina, Uruguay, Venezuela, and U.S.S.R. The largest delegation, 144, was from Britain. Total attendance amounted to several thousands.

The Congress was divided into 14 sections which included several relating to chemistry in agricultural and applied botany; and chemistry as applied to zoology and veterinary science. Among these were a number of papers, abstracts of which appear below. Complete texts of the papers are not expected to appear for some months, since they await publication of "Proceedings of the Congress."

Insecticides and Fungicides

MODERN INSECTICIDES. *By F. P. Coyne.* After a brief reference to the position of insecticide developments in 1939, the very different picture in 1947 is considered. The emergence of a number of new insecticides characterized by an extremely powerful contact effect, a low dosage, and by a marked degree of persistence, has caused a revolution in applied entomology.

DDT, "Gammexane," "1068," and "Toxaphene" are cited in chronological order and some consideration is given to the question of chemical composition and its relation to physiological action. Although all these chlorinated hydrocarbons are readily decomposed to inactive bodies by alkali due to dehydrohalogenation, this facility alone does not account for their insecticidal activity. With DDT and "Gammexane" there is a marked difference in the highly toxic action to insects and other cold-blooded animals compared with the comparatively low toxicity to mammals, so that a high factor of safety exists in the majority of formulations on the market. The additional long term toxicological information required is being obtained on both products and similar extended data will have to be provided for "1068" and "Toxaphene."

Future competitors in this field will have to achieve an extraordinarily high standard in order to replace those now available, and it is suggested that developments in the immediate future are more likely to arise from:—

(a) Production of formulations devised for specific purposes.
(b) Application techniques.
(c) Concentration of effort on entomological problems for which the present new group is not particularly effective.

Progress will necessitate the combined efforts of specialists of universities, research institutions, industrial organizations and government departments.

This report was written especially for Agricultural Chemicals covering sections of the London Conference dealing with insecticides, fungicides, and fertilizer materials. The Conference itself attracted chemists from 21 nations during its eight-day session in London, England, July 17 to 24.

TOXICITY OF DDT. *By G. R. Cameron.* This deals with hazards to human beings arising from absorption of oily solutions through the skin, inhalation of mists, sprays or aerosols, and contamination of food. DDT is not a powerful poison and gives warning by premonitory symptoms and an increase in the number of white corpuscles in the blood. Its main action is on the central nervous system, especially the cerebellum and the higher motor cortex, whereby periodic convulsive attacks resembling epilepsy and bouts of trembling result. DDT can also damage the liver and, to a lesser extent, the kidneys, heart and voluntary muscles. It is stored in some tissues, especially the liver and fat and may be excreted in the milk, so that cumulative effects may follow, but these are not of such an order as to warrant alarm. No genuine evidence of hypersensitization has been recorded. Prevention of DDT absorption by cleanliness, wearing a respirator when spraying, and elimination of all chances of food contamination must be insisted upon. No antidote is available, though urethane and phenobarbital are effective in controlling the nervous symptoms of acute poisoning. Urinary excretion must be encouraged with saline cathartics. Fat should be discontinued in the food and protein digests and methionine administered if liver injury is suspected.

MODE OF ACTION OF CHLORINATED HYDROCARBONS — WITH SPECIAL REFERENCE TO DDT INSECTICIDES. *By H. Hurst,* Department of Colloid Science, Cambridge University. A preliminary study of the insecticidal action of DDT and related compounds revealed a close parallelism between insecticidal activity and the increase in water loss by transpiration through the insect

cuticle. This desiccating action is due to the displacement of protective lipid in the cuticle, and is analogous to the action of simpler fat solvents and fat solvent mixtures. In the range of fat solvents (a) xylene, (b) toluene, (c) benzene, (d) chlorobenzene, (e) chloroform, the desiccating action on insects increases from (a) - (e), but chloroform is outstanding in its dispersant action on the cuticle lipids and the lethal action on the insect. These results formed a basis for the working hypothesis that the activity of DDT is partly due to the physical association of the insecticide with the lipids of the cuticle and internal cell membranes, and that the secondary lethal action is associated with an irreversible change in structural organization. The validity of this assumption is supported by the following results:

When an insect is in contact with a fine adsorbent powder, such as alumina, there is a competition between the powder and epicuticle for the mobile lipids which restrict water loss. The outward displacement of lipid from the epicuticle results in a decrease in the susceptibility of insects to the contact action of DDT and the structurally unrelated pyrethrins. With the latter, insect recovery from primary symptoms of poisoning takes place after treatment with dusts, which alone result in death from desiccation at a later stage. There is a distinct coincidence between the desiccating action of "inert" dusts and their "antidote" action on DDT and pyrethrin poisoning. Abrasive action on the cuticle of emery cloth results in desiccation of the insect, but no antagonism of insecticidal activity.

The toxication of DDT and analogous compounds appears to be due to the indirect blocking of the cytochrome oxidase and succinic dehydrogenase systems of the neuromuscular system by uptake and storage of insecticide in the phospholipids of the cell membranes. The relative resistance of insects depends on the stability of the structural lipoprotein associations of the cuticle, and internal cell membranes. The transition from primary paralysis or narcosis to the lethal stages of poisoning is associated with an irreversible decrease in the stability of the lipoproteins.

RELATIONSHIP BETWEEN CHEMICAL AND INSECTICIDAL PROPERTIES AMONG CHLORINATED HYDROCARBONS AND ORGANIC PHOSPHATES. *By Hubert Martin,* Long Ashton Research Station, Bristol. Of the chlorinated hydrocarbons $(Cl,C_6H_4)_2$ CR. CR_3, where R=H or Cl, only those compounds capable of ready dehydrochlorination have noteworthy insecticidal properties. For this reason it was suggested (Martin and Wain, *Nature,* 1944, 145, 512) that, in these and related compounds, insecticidal activity is dependent, in addition to the normal requirements of permeativity and stability, enabling the compound to reach a sensitive interface within the insect, upon the ease of dehydrochlorination.

The more recent applications of this hypothesis are reviewed. The original observation that the fully chlorinated DDT analogue $(ClC_6H_4)_2CCl.CCl_3$ is non-insecticidal, whereas the DDT isomer $(ClC_6H_4)_2CCl.CHCl_2$ is insecticidal, has been confirmed; the former does not dehydrochlorinate. Of the DDT isomers containing the group -CH.CCl_3, insecticidal potency runs parallel to ease of dehydrochlorination, the *o-o'* isomer being almost non-insecticidal and stable at room temperature to N/10 alcoholic alkali. Among compounds differing from DDT only in the nuclear substituent, those resistant to dehydrochlorination e.g. the bis (2:2 dimethyl)-, the bis 2:5-dimethyl)-, and the bis (4-chlor-2-methyl)-phenyl trichlorethanes have little, if any, insecticidal action. A like relationship is shown in the corresponding dichlorethanes. Of the isomers of hexachlor-cyclohexane the beta-isomer is non-insecticidal and is resistant to dehydrochlorination by N/10 alcoholic potash at room temperatures.

With non-volatile chlorinated hydrocarbons showing ready dehydrochlorination, the establishment of a close agreement between stability to alkali and insecticidal potency is frustrated because, although it may be possible to arrange these compounds in their order of stability to alcoholic potash, their relative insecticidal efficiency varies, according to the test insect used. It is possible that the relative permeativities of the compound may likewise vary.

The insecticidal activity of certain organic phosphates has been confirmed and an important toxophoric grouping appears to be -O.PO.$(OC_2H_5)_2$. Evidence is given of the relationships between molecular structure and systemic insecticidal properties.

BIOASSAY OF AGRICULTURAL FUNGICIDES. *By S. E. A. McCallan,* Boyce Thompson Institute for Plant Research, Inc., Yonkers, New York.* Much progress has been made in bioassay of fungicides in the last decade, largely because of demand for rapid assessment of new chemicals, and use of statistical procedures.

Statistical interpretation has brought out such important relations as the dosage response curve, distribution of populations, errors of technique, experimental designs, and necessary significant differences.

Most laboratory methods appropriately have attempted to assay protectant value. Interest in standardization is emphasizing such methods as the slide germination with its attendant fund of basic information. Various developments have stressed precision apparatus for applying the chemicals.

The more complex relation of fungus, host plant and chemical is receiving more attention by the development of greenhouse methods employing such diseases as apple scab and rust, early and late blights of tomato, cereal smuts and pea seed decay.

Part II of the London Conference report will appear in the October issue. It will present abstracts of papers given on fertilizers and soil constituents in various parts of the world.

* Complete text of Dr. McCallan's Fungicide article appears on page 31, this issue.

Bioassay of Agricultural Fungicides

By

S. E. A. McCallan*

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IN the past decade more progress probably has been made in the quantitative bioassaying of fungicides than in all previous time. This has been due largely to the tremendous demand for information on the possible fungicidal value of new chemicals and to the use of statistical procedures in developing methods and assaying data. It has been estimated that within this period at least 25,000 compounds have been tested as possible fungicides (23). Obviously the vast majority of these cannot have been evaluated by the expensive and time consuming field methods, but instead by methods of bioassay of one kind or another.

Attempts to test fungicides in the laboratory date from the beginning of the science of plant pathology and until recently most investigators evolved their own methods. Much of the earlier work centered around attempts to explain the nature of fungicidal action, but more recently there has been research on improvement and understanding methods of bioassay as an end in itself. It is desirable, however, that these two points of view should be kept in close harmony. Interest in, and sponsorship of, standardization by professional societies, such as the American Phytopathological Society has tended to clarify the divergence in some of these methods. Further the very requirements for standardization have required a more intimate knowledge of the factors involved and these in turn have stimulated research on methods of bioassay.

It is the plan here to discuss some of the factors involved in bioassay of agricultural fungicides, such as the general types of methods, interpretation of data, accomplishments and limitations. Other points of view have been presented by Martin (37, 38) and Horsfall (20, 21).

Fungicidal Action

THE action of most fungicides is protective (1), that is the chemical suitably applied protects the as yet healthy plant or plant part from infection by fungi. Commonly we are attempting to protect the foliage or fruit from invasion by fungus spores which sooner or later may be expected to fall on their surface, or to protect healthy seeds or other storage organs from fungi already present on their surface or immediate environment. Most methods of bioassay have appropriately attempted to evaluate the necessary protective properties of a fungicide.

A chemical may exert its protectant properties either by merely inhibiting the fungus, a fungistatic action, or by the outright killing of it, a true fungicidal action (30). Most methods of bioassay do not distinguish between those two actions.

In a very few cases it is possible to disinfect a plant already infected by means of disinfectant fungicides. The chemotherapy of plants is a new and intriguing field. Also plants, in theory, may be immunized against fungus diseases by the application of suitable chemicals (20). These types of fungicidal action, however, from a practical view are as yet rare and there is little information as regards methods of bioassay though it is a field of great potentialities.

Methods of Bioassay

METHODS of bioassaying fungicides are of two classes, those concerned with the interacting system fungus and chemical and the system fungus, chemical, and host. Methods dealing with the system fungus and chemical also have been called *in vitro*. These are comparatively simple as regards segregation of factors. They lend themselves particularly well to a study of the nature of fungicidal action and to relatively high precision and further, they are generally more rapid of execution. However, the results obtained may be more academic than practical since they ignore the host relation and hence are further removed from field application. These methods are best fitted for preliminary tests.

Methods dealing with the interacting system of fungus, chemical and host, on the other hand are biologically more complex. In some cases they are appropriately called greenhouse methods when concerned with greenhouse plants. With these methods the segregation of factors is more difficult and the precision tends to be lower. They are likely to be more time consuming and expensive as regards space and equipment. However, they more nearly approach field conditions and hence can better demonstrate specificity of chemical action and so can be considered more practical.

Fungus and Chemical

LABORATORY *in vitro* methods of testing protective fungicides are based on different principles which may be classified into three general types:

A. Spores are suspended in solutions (or suspensions) of the chemical, removed at stated intervals and the presence or absence of growth

* Given at International Chemical Congress, London, England, July 19, 1947.

or germination on a suitable medium observed.

B. The chemical is incorporated with a solid or liquid nutrient medium, spores or mycalium added and their growth noted.

C. Spore suspensions are exposed to the chemical on glass slides held in moist chambers and the percentage germination recorded.

The first method is an adoption from the Rideal-Walker bacteriological technique. It measures true fungicidal or killing properties of the chemical and is most practical for soluble materials, for unless the extraneous chemical can be removed the germination in the presence of residues of the chemical is similar to method C. Method B while simple and used by some laboratories for initial screening also like method A disregards various physical factors and unnecessarily complicates the system by the addition of the physiochemically active nutrient medium. In the third method the spores may be suspended in solutions or suspensions of the chemical and drops pipetted on the slides, or the slides may be sprayed or dusted first and the drop of spore suspension added. The first technique is very simple and while the latter is more involved it attempts to approach field conditions and assess such physical factors as spread and tenacity (1). This method has been extensively developed and is standardized by the American Phytopathological Society (2, 4). Considerable latitude is given in the choice of minor alternate procedures and the method is widely used for the bioassay of fungicides.

Fungus Environmental Factors—The species of fungi most commonly used, especially with method C, are *Sclerotinia fructicola, Stemphylium sarcinaeforme* (Cav.) Wilts., [formerly known as *Macrosporium sarcinaeforme* (27)], *Venturia inaequalis, Glomerella cingulata, Alternaria oleraceae,* Milbraith, [formerly mistakenly called *A. solani* (27)] and various other species of *Alternaria.* It will be noted that these species cause diseases of foliage or fruit where a protective fungicide is called for, and that two, *S. fructicola* and *V. inaequalis,* cause two diseases of major economic importance, namely, brown rot of stone fruits and apple scab. The fungi chosen are selected primarily on the basic of ease of handling and economic importance. They are cultured on the most favorable media, generally at optimum temperature for spore production and used when the spores are at an optimum age for high percentage of germination and resistance to chemicals.

Earlier workers (and to some extent present ones!) have been plagued by erratic germination responses by the check or control fungi which results in much greater fluctuations in the test responses. This has been reduced largely by a rigid attention to environmental detail and especially in some fungi by a study of spore germination stimulants. The erratic responses by *Sclerotinia fructicola* were found to be due to indeterminate quantities of unknown stimulant dissolved from the potato dextrose agar culture medium (34). This could be removed by washing the spores but a substitute of constant stimulant properties to induce high germination was needed and ultra filtered orange juice at a strength of 0.1 percent is being used successfully. Other workers have employed such stimulants as coenzyme R (14), extracts from dried potato dextrose agar (46), and potassium or sodium citrate plus sucrose (41). By those means consistently high and stable percentages of germination are insured and the efficiency of the assay correspondingly increased.

Application of Fungicide—In the simpler laboratory methods where one or several concentrations of the chemical are tested, orthodox chemical methods of dilution will usually suffice, though approximations are suggested in some cases (4) since they are usually within the limits of biological error and requirements of initial screening. Unfortunately many chemicals are not soluble in water or even readily suspendable. In those cases wetting agents may be used or organic solvents such as dilute acetone which has no marked effect on germination. However, each case is a specific one, and the toxicity of the chemical may be altered by the addition of these materials.

Where the attempt is made to include additional physical factors and to apply the chemical as a spray or dust more or less approximating field conditions, it is necessary to have special application apparatus. Techniques for spraying have been investigated principally by the following workers and their associates: Martin (9), Horsfall (19, 22), McCallan (35), Frear (12) and Ciferri (7). The sprays are delivered through various types of nozzles in a horizontal (9, 12, 19, 22) or vertical stream (7) on to glass slides, or a settling tower may be used (35). Comparisons of horizontal sprayers and settling towers indicate that the latter will give greater reproducibility and precision but that it is slower. Concentration of spray deposit is regulated by time of exposure. Elaborate apparatus has been built in these studies in an effort to obtain greater precision and this has been successful. However, at present, an extension of such work is likely to be unprofitable because of other factors such as specificity of fungicidal action and lack of correlation with field results. In the case of dust application further work can very profitably be done since so far we have no simple and precise technique.

The importance of such physical factors as distribution and spread leads to an examination of the type of surface on which the spore tests are made. Most investigators have used chemically clean glass, others, however, claim that cellulose nitrate provides a more uniform surface, with less spread and greater similarity to a leaf surface (9, 19, 22, 40).

It is essential that foliage fungicides be able to withstand weathering, that is, they must show a high degree of tenacity. Accordingly attempts have been made in the laboratory to devise weathering tests such as agitating sprayed and dried slides in water (18, 42) atomizing the slides with water (40) or exposing to artificial rain (35). After a second drying the customary germina-

tion tests are made. While these methods bring out differences in tenacity they have not been particularly well correlated with field results as shown for example by Miller (40) and considerably more study is in order.

Fungus, Chemical and Host

THE principal methods concerned with direct disease control developed so far are of these general types: A. Foliage diseases. B. Seed borne diseases, especially cereal smuts. C. Soil borne diseases of the "damping off" group.

Foliage Diseases—The development of foliage disease tests has presented the greater problems in technique and apparatus. Pioneer work has been done by Hamilton (15). Among the diseases more commonly used are: apple scab, *Venturia inaequalis;* cedar-apple rust, *Cymnosporangium juniperi-virginianae;* tomato early blight, *Alternaria solani;* tomato late blight, *Phytophthora infestans;* snapdragon rust, *Puccinia antirrhini;* downy mildew of grapes, *Plasmopara viticola;* powdery mildew of beans, *Erysiphe polygoni;* bean rust, *Uromyces appendiculatus;* and powdery mildew of hop, *Sphaerotheca humuli.* The last mentioned hop mildew method used by Salmon and coworkers (10) is a special case of disinfection or eradication in that the chemicals were tested on plants already infected with powdery mildew. While these diseases include many of outstanding economic importance, unfortunately in too many cases the methods have not been sufficiently worked out or described as a satisfactory means of bioassay. The apple diseases suffer from a disadvantage of seasonal development and relative expense of experimental trees.

The causal organisms are carried preferably in culture or if necessary, on stock plants. In the case of seasonal diseases stocks of spore material may be frozen until required (17). In order to get optimum infection it is necessary in many cases to have a high degree of humidity and controlled temperature for which special infection chambers have been developed (15, 16, 31).

Healthy stock plants are sprayed on a turn table with a series of concentrations of the chemical by means of various laboratory spray guns. In the case of the more highly developed methods the amount of spray deposition in a given system is known for such factors as time and pressure of spraying, ratio of liquid to air, size of plant and leaf position (31). After drying, the plants are inoculated with the spore suspension obtained under standard conditions and immediately placed in the infection chamber for a set period, usually about one day. The plants are then returned to the greenhouse and in a more or less constant time necrotic lesions or pustules appear which are counted and compared to standard materials.

Efforts to develop weathering techniques involving exposure to laboratory "rain" and periods of growth between spraying and inoculation have so far been only partially successful (16,50) and more research is required.

Preliminary studies by Marsh (36) on apple scab using detached leaves have not been followed by others. It is questionable if such methods intermediate between glass slide and potted plant are likely to be satisfactory, for they lack the ease and precision of the former and specificity and practicability of the latter. Few comparisons between tests on slides and on leaves have been made; Marsh, however, found that fungicides performed less well on the leaves. In an identical comparison with *Alternaria solani* spores applied at the same spore concentration per unit area, McCallan and Wellman (31) found that the performance of two fungicides on glass slides and on tomato plants was the same as the 50 percent response level. Correlations involving different types of methods showed (49) fair agreement between slide tests and greenhouse tests with tomato foliage diseases and wheat smut except for organic nitrogen compounds where tautomerization was known to be possible.

Seed Borne Diseases—Most studies on the bioassay of chemicals to control seed borne disease have been concerned with the cereal smuts especially bunt of wheat, *Talletia tritici* and *T. levis.* Earlier methods developed in Germany have been replaced by more practical greenhouse methods. Here grain naturally or artifically infested is dusted with the test chemical, planted and held at a suitable temperature, then removed to the greenhouse to await development of smutted heads. The major disadvantage is the length of time required. Such methods have been standardized not only for bunt but also loose smut of oats (*Ustilago avenae*) and other cereal smuts by the American Phytopathological Society (3).

A simple method has been devised by Muskett (43) for evaluating fungicides to control the Helminthosporium disease of oats. Infested seed treated with the chemical is placed on moistened filter paper in moist Petri dishes. After a given time the seed is irradiated which induces sporulation thus permitting identification of ineffective treatments. This method with modifications has been extended to include infested flax seeds (44).

Soil Borne Diseases—There is relatively little information on methods of assessing the value of fungicides in preventing the infection of plants or seeds from soil borne fungi. Seeds may be treated with chemicals to protect them from decay by soil organisms and also possibly to give some protection to the seedlings. Pea seeds have been used successfully as a criterion in several laboratories. Here the seed is treated with the chemical dust and planted in soil naturally or artifically infested and subsequently the percentage emergence of the seedlings is determined. Recent quantitative studies (28) indicate that the pea seed treatment method is capable of high precision. It is very simple and the nearest approach to an actual field test that one is likely to get in a simple method of bioassay.

Interpretation of Data

THE use of statistical procedures in the bioassay of fungicides is proving invaluable both for designing experimental test methods to assess the relative importance of various factors and for the comparison of the relative merits of different fungicides. Discussions of these procedures may be found in texts by Fisher (11), Snedecor (47), and others.

The Dosage Response Curve—The response of organisms to the action of a toxic agent is of two types; those in which there is a progressive change such as in the diameter of fungus colony growth, and those in which the response is either of two categories such as dead and alive or germinated and non-germinated. This latter is called a quantal or all or none response and is the one of interest here. Individual organisms differ in their sensitivity to chemicals so, as the concentration of the toxic chemical increases, more organisms fall into the second category of dead. In actual practice usually only a summation of the two responses can be obtained for the varying dosages of chemical so that when percentage dead is plotted against dose of chemical the familiar sigmoid curve results. From the studies of Gaddum (13) and Bliss (5) it appears that in many cases the logarithm of the individual lethal doses is normally distributed. By converting the percentage response units to units of the standard deviation of their normal distribution curve, i.e., the "normal equivalent deviations" of Gaddum or "profits" of Bliss, and plotting against logarithm of doses, a straight line response will result. This linear function simplifies many statistical calculations and Bliss (5, 6) has given procedures for determining the relative potency of chemicals at any level of response and the parallelism of the curves. Comparisons are usually made at the most precise mid point of 50 percent response, i.e., the LD50 of Trevan (43). However, in foliage disease tests where the lesions are expressed as a percent of the check the most precise point is nearer the level of the LD95 (24, 25) which fortunately in this case is also of more practical interest. In many cases the test data do not warrant precise calculation and reasonable approximations may be made by plotting the results on logarithm probability graph paper and estimating the LD50 (33, 53).

While the relative horizontal position of the LD50 indicates the potency of the chemical, the slope of the transformed dosage response curve is presumably determined from the nature of the fungicidal action. Steep curves show homogeneity of response on the part of the organism and flat curves lack of homogeneity. There is evidence that the slope of the curve is more a function of the chemical than of the fungus (33) and similar slopes of closely related compounds are probably due to a common toxic ion (39). Since two chemicals may have different slopes it is possible for one to show more toxicity at a low level of response and the other at a higher level of response. This crossing over of the curves may explain reversals of effectiveness both in laboratory and field results (8). Frequently new chemicals are compared in terms of a standard fungicide, but unless the standard and unknown are essentially alike chemically and thus have similar slopes, close comparisons cannot be made (6, 33). Laboratory spore germination tests tend to give steep curves while greenhouse foliage disease tests, even with the same organism, give much flatter curves (31). Likewise seed germination tests give flat curves (28)These flat curves are also obtained with field observations.

Unfortunately in too many cases the log-probit transformation does not produce a straight line response. Instead curves, concave, converse or sigmoid have been found (33); there are even curves with double maxima (8). Parker-Rhodes (45) has postulated that the individual lethal doses are symmetrical when plotted against an exponential transformation of the dose; the exponent is called "A." Such a transformation will straighten curves of the J or concave type. However, curves that break to the right, i.e., convex upwards, will require a negative "A" transformation (29), while for more complex curves the transformation is ineffective. Plainly we do not yet have all the answers to explain the shape of dosage response curves, but the necessity of exploring more than one dose is apparent.

Significant Differences—It is desirable to know the magnitude of the difference between treatments or chemicals which may be considered significant. In cases of special precision and interest orthodox calculation as given by Bliss (5, 6) or Snedecor (47) are desirable; frequently however, approximations will suffice. Very rapid and simple approximations using the ranking order have been developed by Wilcoxon (51, 52).

Due to biological and other variation a given set of chemicals may vary in their apparent effectiveness from test to test and in such cases, rather than use the smaller "within test" error the "chemical X test" interaction is to be preferred (32) as the conclusions will rest on a wider basis of inference. In these cases it is more efficient to run fewer replicates in a given test and more tests. As a method becomes standardized in a laboratory it is possible to capitalize on past experience by building up "cumulative error terms" (32) which if found to be homogenous with a current test may be used to reduce the significant difference in that particular test.

Correlation of Bioassay Methods

"THE proof of the pudding is in the eating" and unfortunately field results have often upset the expectations of laboratory bioassay. It is expecting too much, with our present knowledge, for a simple laboratory test involving only fungus and chemical to determine alone a practical field fungicide even though as Horsfall points out (20) several good fungicides have been discovered by the slide germination method. In another case an effective fungicide, thiourea, showed no promise by this test (23). Such methods must be limited to initial screening tests to

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Effect of Light on DDT Residues

By R. D. Chisholm and L. Koblitsky

U. S. D. A., Agr. Research Adm., Bureau of Entomology and Plant Quarantine

SEVERAL studies have been made of the stability of DDT and of its rate of evaporation. A review of many of these studies has been presented by Cristol and Haller (1945). Fleck and Haller (1944 and 1945) have shown that a number of compounds commonly found, at least in traces, in insecticide mixtures act as catalysts causing decomposition at temperatures a little above the melting point of DDT. These compounds include anhydrous aluminum, chromium, and ferric chlorides and certain other iron-containing materials. Cristol (1945) has demonstrated that the *o,p'* and *p,p'* isomers of DDT are easily dehydrohalogenated through the action of alcoholic alkali. Fleck (1944), after studying the rate of evaporation of recrystallized DDT at 45° C. in an air bath, concluded that the material would last more than 18 months. This paper reports a study of heat and sunlight on DDT.

Recrystallized and technical DDT were dusted, in triplicate, into petri dishes at the rate of about 3 mg. per square centimeter. The deposits were weighed at 24-hour intervals during exposure in an oven at 50° C. (112° F.) for 72 hours, and the weights compared with those of the original deposits. The recrystallized-DDT deposits decreased about 0.25 percent, about three-fourths of the loss occurring in the first 24 hours, and the technical-DDT deposits decreased a little less than 1.5 percent,

TABLE I

Percent of DDT and ratio of hydrolyzable to total chlorine in mixtures of DDT and a diluent before and after exposure to sunlight at summer temperatures.

Diluent	Recrystallized DDT				Technical DDT			
	Original mixture		Exposed deposit		Original mixture		Exposed deposit	
	Percent* DDT	Ratio of hydrolyzable to total chlorine	Percent* DDT	Ratio of hydrolyzable to total chlorine	Percent* DDT	Ratio of hydrolyzable to total chlorine	Percent* DDT	Ratio of hydrolyzable to total chlorine
Bancroft clay	48.2	0.224	51.2	0.209	49.9	0.211	47.9	0.207
Bordeaux mixture	49.6	.204	48.2	.207	48.1	.211	45.8	.219
Celite	48.9	.208	48.3	.209	48.6	.214	47.4	.216
Fermate	49.3	.208	50.4	.216	48.1	.217	46.7	.228
Hydrated lime	49.0	.200	44.2	.203	48.6	.204	39.2	.208
Limonite	49.1	.208	47.7	.208	48.0	.212	44.2	.215
Pyrophyllite	47.0	.223	47.9	.205	48.6	.213	46.2	.210
Sulfur	48.1	.213	56.3	.212	48.3	.211	52.2	.211
None	100.1	.201	97.1	.210	98.7	.208	93.1	.213

*Calculated from total-chlorine determinations.

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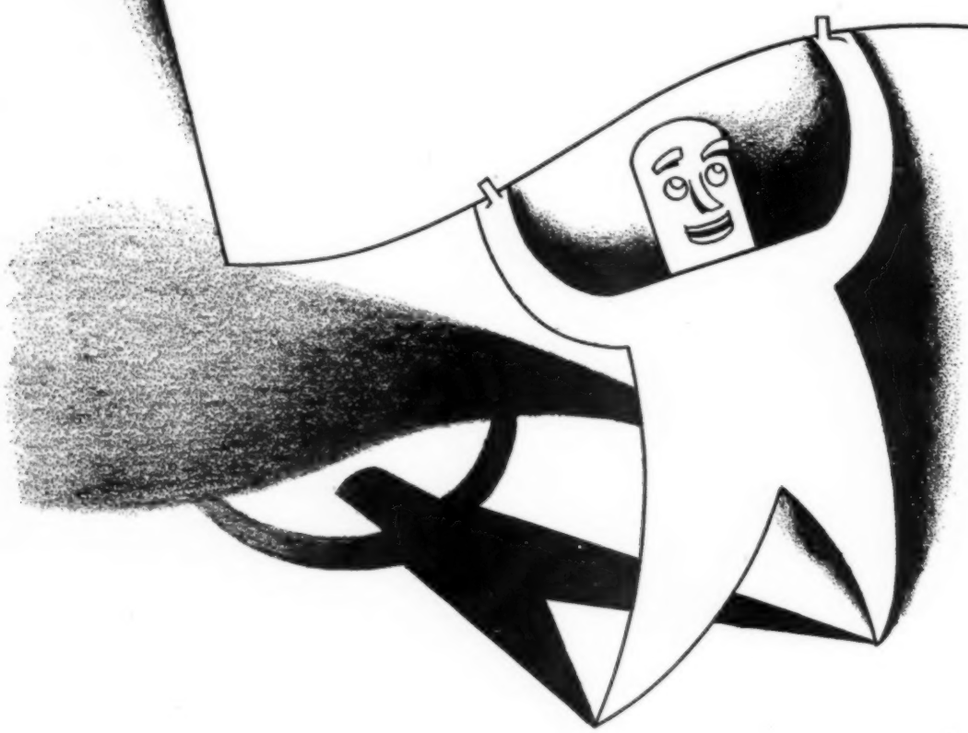

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about one-half being lost during the first 24-hour period. The color of the deposits remained unchanged during the entire 72 hours.

Recrystallized and technical DDT were mixed with equal weights of pyrophyllite. A portion of each mixture was micronized and the remainder brushed through a 100-mesh screen. The four mixtures were dusted, in triplicate, on tared glass plates, which were then weighed and placed in shallow trays. These were then exposed in sunlight after being covered with uncoated perforated cellophane to provide for a high degree of light transmission and to minimize wind losses during exposure. Exposures were made during the summer on calm days at times when the sun was brightest. After 64 hours, the plates were reweighed and the losses in weight were calculated. The percentages of loss for the micronized and 100-mesh mixtures were 9.3 and 3.4 for those made with recrystallized DDT, and 20.3 and 22.0 for those made with technical DDT.

In other tests, recrystallized or technical DDT was ground together with approximately equal weights of several diluents and the mixtures brushed two times through a 100-mesh screen. The diluents were Bancroft clay, bordeaux mixture (1:1), "Celite" (a diatomaceous earth), "Fermate" (ferric dimethyl dithiocarbamate), hydrated lime, limonite, pyrophyllite, and crude sulfur. Five grams of each mixture was wetted with a 0.1-percent aqueous solution of a surface-active agent to form a paste which was then distributed evenly on three 5 x 7-inch glass plates. After drying, the coated plates were placed in uncovered shallow trays and exposed as previously described. After a cumulative exposure period of 64 hours the deposits were scraped from the plates and extracted with benzene. These extracts were then analyzed for total and hydrolyzable chlorine by the methods of Umhoefer (1943) and Gunther (1945). The results, compared with those obtained from similar analyses of the original mixtures, are presented in table 1.

The data show that DDT is lost from deposits on exposure to sunlight at summer temperatures. The losses from the dusted deposits containing recrystallized DDT were small. Those from the deposits containing technical DDT amounted to about one-fifth of the DDT in the original mixture. Comparison of these results with those obtained by heating the DDT in the oven indicates that the loss in weight is accelerated by sunlight. In most cases the proportion of DDT in the uncovered paste deposits was less after exposure than in the original mixtures, which indicates that DDT had been lost from such deposits (table 1).

The greatest decreases occurred in the deposits containing hydrated lime, possibly owing to increase in weight of the lime due to hydration while the mixtures were wet or due to carbonation during exposure. The proportion of DDT in the sulfur deposits was greater after exposure than it was in the original mixtures, an indication that the sulfur volatilized faster than the DDT, particularly the recrystallized grade. These differences suggest that the use of a relatively volatile diluent, such as sulfur, in DDT formulations may give deposits which provide for the uncovering of fresh DDT on volatilization of the diluent, and thus prolong the toxicity of such deposits.

The ratios of hydrolyzable chlorine to total chlorine in both the original and the exposed residues are all over 0.200, the theoretical ratio for undecomposed DDT. Decomposition by loss of hydrogen chloride is measured by change in the ratio of hydrolyzable to total chlorine and may be demonstrated by ratios less than the theoretical. DDT therefore appears to be compatible with the several diluents under summer conditions. However, an indication of partial decomposition due to exposure was noted in the tan color of the exposed dusts, particularly those containing technical DDT. This suggests that under field conditions decomposition may be limited to the exposed surfaces. Thus, reduction of toxicity to insects during exposure may not demonstrate that the components of a deposit are incompatible. The amounts of DDT determined in deposits containing no diluent were less after exposure than they were in the original materials. This suggests that part of the DDT may have decomposed or become partially insoluble in benzene, the solvent used in the analyses.

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FAO Studies Food Losses

At least 5 percent of the cereal foods produced throughout the world are ruined in storage by insects, Dr. R. T. Cotton of the U. S. Department of Agriculture reported to the United Nations Food and Agriculture Organization in London at a recent hearing. The group also heard from Dr. A. G. Johnson of the U.S.D.A., who stated that at least one percent of the world's grain crop is lost annually to the depredations of fungi.

Dr. Cotton stated that much of the storage loss could be prevented through the use of residual insecticides in empty storage places, so that insects may be killed before infestation gets under way. He also stated that treatment of seed grains with a dust containing about 1 percent of DDT or with non-poisonous dusts such as magnesium oxide, kills the insects and helps to insure a supply of good seed for planting.

Dr. Johnson pointed out that most losses from fungi take place in humid regions.

Production, Consumption, Foreign Trade of

PLANT FOOD in the U. S.

BOTH the production and consumption of fertilizers in the United States have increased markedly in recent years. The relative importance to the United States of foreign trade in plant food has changed rapidly. The purpose of this paper is to show the extent of these changes from 1930 to 1946, to revise a few of the figures previously published and to present preliminary estimates for 1946. All of the data in this paper relate to calendar years and short tons.

Nitrogen

The position of the United States with reference to fertilizer nitrogen in recent years is outlined in table 1. The source of the data and their limitations are indicated in footnotes. The five-year averages at the bottom of the table in comparison with the 1945 and 1946 figures bring out the trends in the data. The 1930 figures may be taken as the last normal figures before the depression and the 1935-39 average as about normal for the prewar period.

Total consumption of nitrogen in the form of commercial fertilizers decreased in 1932 to only 57 percent of what it was in 1930. It then increased gradually until the beginning of World War II. The average consumption in the 5-year prewar period 1935 to 1939, inclusive, was almost exactly the same as it was in 1929 and 1930. A shortage of nitrogen developed in 1942 owing to the demand for it in the manufacture of munitions. In spite of these war demands, however, the consumption of nitrogen as fertilizer continued to increase rapidly. In 1946 an all-time record of about 730,000 tons of nitrogen for fertilizer use was established. This is 7 percent more than was used in the previous year, about double the 1935-39 average, and 2.6 times the 1930-34 average consumption.

While the total consumption of nitrogen increased, that of natural organic nitrogen decreased. In recent years the consumption in the organic form was only about one-half what it was 15 years before, when the total consumption was much less. In 1930 16 percent of the total N in fertilizers was derived from natural organics. In recent years only about 5 percent came from this source. The imports of nitrogen in the form of natural organic fertilizers also have declined until they are almost negligible.

TABLE 1.—Fertilizer Nitrogen for U. S. Agriculture[1] (1000 short tons N)

Year	Chemical nitrogen for fertilizer use				Natural organic nitrogen		Total cons'mpt'n. of nitrogen as fertilizer[7]
	Apparent prod.[2]	Imports[3]			Net imports[5]	Cons'mpt'n.[6]	
			Exports[4]	Cons'mpt'n			
1	2	3	4	5	6	7	8
1930	178	164	25	317	10	60	277
1931	122	151	32	241	9	60	301
1932	92	102	34	160	9	54	214
1933	90	130	22	188	14	52	240
1934	128	131	36	223	12	52	275
1935	171	135	45	261	12	51	312
1936	161	181	50	202	17	58	350
1937	199	203	42	360	13	51	411
1938	171	201	37	335	8	49	384
1939	178	206	34	350	8	48	398
1940	244	184	57	371	7	48	419
1941	288	157	35	410	11	48	458
1942	192	187	16	363	3	46	[8]409
1943	300	197	20	477	4	32	[8]509
1944	407	211	10	608	5	32	[8]640
1945[9]	417	251	24	644	3	35	679
1946[9]	546	198	44	700	2	30	730
1940-44 av.	286	187	28	446	6	41	487
1935-39 av.	176	185	42	319	12	51	371
1930-34 av.	120	136	30	226	11	56	281

1 Includes Hawaii and Puerto Rico, and government distributed fertilizers.
2 Consumption of chemical nitrogen in column 5, plus exports in column 4, minus imports in column 3.
3 Data for 1930 to 1935, inc. from "Chemical Nitrogen." U. S. Tariff Comm. Rept. No. 114 2nd ser: p. 188, 1937. Rest of the figures evaluated from imports and exports as published by the U. S. Bureau of Foreign and Dom. Commerce and U. S. Census Bureau.
4 Column 8 minus column 7.
5 Sum of the nitrogen content of the imports minus that of the exports of fertilizer grade natural organics. The exports of this form of nitrogen were negligible. The maximum was 1 thousand tons in 1937 and 1938.
6 Evaluated from "The Magnesium Content of Fertilizers 1850 to 1937" 1939 Yearbook of Commercial Fertilizer and "Materials Used as Fertilizers 1938-1945." Amer. Fert. 106 (5): 7-9, 1947.
7 Figures from 1930 to 1941, inclusive from "Nitrogen, Phosphoric Acid, and Potash Consumption in the United States by Years and by States." Jour. Amer. Soc. Agron. 37(8): 595-609 (1945). Later data prepared in same way, except for 1946, which was estimated.
8 Revised. 9 Preliminary.

by A. L. Mehring and K. G. Clark

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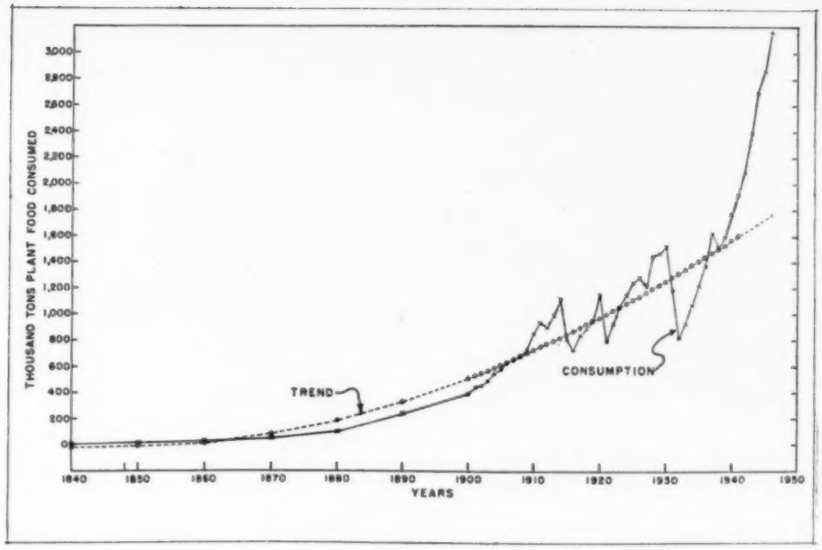

Figure 1.—Plant-food consumption in the United States, 1840 to 1946. (The points on the trend curve were calculated from the equation $y = 0.1728x^2 - 1.248x = 34.855$, which was found by the methods of least squares to be the second degree curve of closest fit.)

The imports of chemical nitrogen have fluctuated from 102 to 251 thousand tons, with an average of 175. The trend has been slightly upward but not in proportion to consumption. In 1930, 46 percent of the nitrogen consumed in the U. S. was imported, and during the 5-year period 1935-39, 53 percent. Since then the relative importance of imports has declined until in 1945 imports represented 38 percent and in 1946 only 27 percent of the total amount consumed. The indications are that in 1947 an even smaller part of the consumption will be imported.

The exports of chemical nitrogen have always been relatively unimportant and those of natural organic nitrogen inconsequential. Except for 1940 and 1944, the total exports of fertilizer nitrogen did not vary more than 50 percent from the annual average of 33,000 tons.

The total production of chemical nitrogen decreased from 289,000 tons in 1930 to 166,000 tons in 1932, and then increased to 1,281,000 tons in 1945. A considerable part of this tonnage was used for the manufacture of explosives, in refrigeration, gold mining and many other industrial uses. The actual production for fertilizer use is unknown. Therefore the apparent production was calculated as indicated in table 1. From these figures it appears that at the beginning of the period, about two-thirds of the domestic production went into fertilizers. But at the end of the period only about one-third was so used. The tonnage of chemical nitrogen consumed in 1930 and 1931 as fertilizer alone was actually larger than the total production. The excess, of course, was imported, mostly in the form of nitrate of soda, from Chile. In recent years on the other hand only about half as much was used in fertilizers as was produced in this country. In spite of this fact we still import chemical nitrogen for fertilizer use. Actual production probably varied less than the apparent production figures in table 1 indicate. The reasons for this belief are that stocks on hand are known to have increased greatly in 1933 and on the contrary they were drained as low as possible in 1942.

TABLE 2.—Available Phosphoric Acid in Fertilizer for U. S. Agriculture (1000 short tons P_2O_5)

Year	Production [1]	Imports [2]	Exports [2]	Consumption [3]
1930	794	29	32	793
1931	478	24	31	611
1932	307	28	11	413
1933	463	34	14	464
1934	509	18	22	530
1935	531	24	21	597
1936	627	28	26	673
1937	805	44	39	794
1938	683	28	34	744
1939	758	22	37	789
1940	876	44	45	912
1941	955	63	52	994
1942	1071	35	60	1131
1943	1273	36	92	[4]1237
1944	1344	55	60	[4]1408
1945	1447	54	64	[5]1438
1946	1566	[5]41	[5]83	[5]1535
1940-44 av.	1204	47	62	1136
1935-39 av.	681	29	31	719
1930-34 av.	510	26	22	562

[1] Compiled from U. S. Dept. Agr. Misc. Pub. 586 (1946) except 1946, which was calculated in the same way from Facts for Industry, "Superphosphate," published by the U. S. Bur. Census. These figures include the P_2O_5 content of ordinary and double superphosphate and wet-mixed base goods, manufactured in Continental U. S., but do not include ground phosphate rock, bone meal or other organics. The other 3 columns include P_2O_5 from bone and organics.

[2] Evaluated from imports and exports as published by the U. S. Bur. Foreign and Domestic Commerce and by the U. S. Census Bur. The data include the P_2O_5 content of bone and other natural organics.

[3] Includes Hawaii and Puerto Rico and Government distribution. The P_2O_5 content of bone meal and organic ammoniates consumed as fertilizer decreased from 50 in 1930 to 36 in 1940 and 20 thousand tons in 1946. See also footnote 6 to table 1.

[4] Revised. [5] Preliminary.

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TABLE 3.—Potash as Fertilizer for U. S. Agriculture[1]
(1000 short tons K_2O)

Year	Production [2]	Imports [3]	Exports [3]	Consumption [4]
1930	61	322	10	354
1931	64	194	20	275
1932	62	96	1	192
1933	143	149	17	222
1934	144	158	17	263
1935	193	229	38	307
1936	247	197	62	350
1937	284	337	61	416
1938	317	187	51	393
1939	312	94	82	409
1940	380	115	56	435
1941	525	13	51	467
1942	679	3	43	547
1943	739	17	60	643
1944	835	4	61	[5]649
1945	874	4	58	[6]746
1946[6]	941	9	55	819
1940-44 av.	632	30	54	548
1935-39 av.	271	209	65	375
1930-34 av.	95	184	13	261

1 Includes Hawaii, Puerto Rico and Government distribution.

2 Compiled from Bur. Mines Minerals Yearbook. Includes the potash content of sales produced both for chemical industry and for agriculture but not of natural organics or ashes.

3 Compiled from Bur. Mines Minerals Yearbooks. Includes K_2O equivalent of materials for fertilizer use only.

4 Includes the K_2O content of natural organics and ashes used as sources of potash in fertilizers which has averaged about 20 thousand tons annually. See also footnote 6 of table 1.

5 Revised. 6 Preliminary.

Phosphoric Oxide

The actual production of available P_2O_5 in superphosphates is shown in table 2. This includes the bulk of the available P_2O_5 in fertilizers, but it does not include that derived from bone and other organics. The other columns in this table include the P_2O_5 content of the organics and the 3 percent of ground phosphate rock that shows up as available by the official method of analysis of fertilizers.

Production of P_2O_5 in the form of superphosphates nearly doubled since 1930. The trends in production, imports and exports also have been upward. Foreign trade in soluble phosphates has always been relatively small and the imports nearly balance exports most years.

From 1930 to 1941, inclusive, exports of phosphate rock averaged 1,105,000 tons and in each of these 12 years, except 1932, the figure was relatively close to this average. Since 1941 the exports have been much smaller. In the thirties about one-third of the U. S. production of phosphate rock was exported. In recent years, however, the net exports were only about six percent of production.

Consumption of P_2O_5 has about doubled since 1930. A substantial part of this increase is due to the Agricultural Conservation Program of the Department of Agriculture and to a much lesser extent to the Farm Demonstration Program of the Tennessee Valley Authority. In 1945 one-third of the P_2O_5 consumed in U. S. agriculture was supplied to the farmer for carrying out certain conservation practices with government assistance.

The agricultural conservation program has involved fertilizers in three ways. (1) The Government has distributed superphosphate or mixed fertilizers purchased on contract. (2) The farmer has been given a purchase order good for a specified quantity of fertilizer. (3) The farmer has bought and paid for the fertilizer. Having used it in approved ways he was compensated by the Government for its use. In the early years of the program the Government paid 100 percent of the cost; in recent years the Government contribution has been gradually reduced until now it is only about 60 percent. This program started in 1936 with the Agricultural Adjustment Administration paying for 40,531 tons of P_2O_5. The quantity increased every year until in the 1945 program, 480,286 tons of P_2O_5 were thus used, with quantities of potash and other materials.

(*Turn to Page 61*)

TABLE 4.—The Available Plant-food Position of the United States

Year	Apparent prod.[1]	Cons'mpt'n.[2]	Exports [2]	Imports [2]	Proportion of cons'mpt'n produced [3]	Proportion of prod. exported [4]	Proportion of cons'mpt'n imported [5]
1	2	3	4	5	6	7	8
	1000 Tons	1000 Tons	1000 Tons	1000 Tons	Percent	Percent	Percent
1930	1,066	1,524	67	525	69.95	6.29	34.45
1931	892	1,187	83	278	75.15	9.30	31.84
1932	730	819	46	135	89.13	6.30	16.48
1933	652	926	53	327	70.41	8.13	35.31
1934	824	1,068	75	319	77.15	9.10	28.87
1935	920	1,216	104	400	75.65	11.30	32.89
1936	1,088	1,373	138	423	79.24	12.68	30.81
1937	1,166	1,621	142	597	71.93	12.18	36.83
1938	1,351	1,521	155	325	88.82	11.47	21.37
1939	1,419	1,596	153	330	88.91	10.78	20.68
1940	1,572	1,766	156	350	89.01	9.92	19.82
1941	1,813	1,919	138	244	94.48	7.61	12.71
1942	1,978	2,087	119	228	94.78	6.02	10.92
1943	2,307	2,389	172	254	96.57	7.46	10.63
1944	2,553	2,697	131	275	94.66	5.13	10.20
1945	2,697	2,863	146	312	94.20	5.41	10.90
1946	3,016	3,084	182	250	97.80	6.03	8.11
1940-44 av.	2,045	2,172	143	270	94.15	6.99	12.43
1935-39 av.	1,189	1,465	138	415	81.16	11.61	28.33
1930-34 av.	833	1,105	65	337	75.38	7.80	30.50

1 Column 3 plus column 4 minus column 5.

2 Sum of the N, P_2O_5 and K_2O figures in tables 1, 2 and 3.

3 $\frac{\text{Column 2x 100}}{\text{Column 3}}$ 4 $\frac{\text{Column 4 x 100}}{\text{Column 2}}$ 5 $\frac{\text{Column 5x 100}}{\text{Column 3}}$

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Has production outrun the Market? What's the present

Outlook for DDT

The recent announcement of a price reduction on DDT, and the recognition that current productive capacity is well in excess of demand, has focussed attention on the present position and the future outlook for this important insecticide material. Our editorial staff has in recent weeks been questioning producers about production and current productive capacity, and probing too as to possible future expansion of the market for DDT and DDT insecticides. Here are some of the answers they have received, mere opinions or at best informed guesses in many cases, but presented for what they are worth.—THE EDITORS.

REPORTS from trade sources indicate that the productive capacity for technical DDT is rapidly approaching the potential of approximately 100 million pounds per year. Estimates obtained by AGRICULTURAL CHEMICALS directly from many of the producing companies indicate that during the ten month period from September 1946 to June of 1947, 45,000,000 pounds of technical DDT were produced. The same reports indicate that as of today the current capacity is rapidly approaching eight million pounds per month, with an additional one million to one and one-half million additional production available per month should the need require it. It is safe to assume that the 100 million pound figure mentioned above is and can be a stark reality.

Why this production?—Can this quantity of DDT be absorbed by the domestic market?—How much DDT will the export market take?—What will happen to the price of DDT and DDT compositions?—How will the production of DDT be affected by newer insecticides? The editors of AGRICULTURAL CHEMICALS have been seeking the answers to these and other questions connected with the future of DT in a series of interviews with DDT producers and formulators of DDT insecticides over recent weeks.

This brief summary of the current position of DDT—and the outlook for the future—will attempt to explore the answers to these obvious questions,—but due to the very nature of the questions involved and the various intangibles, it is obviously difficult, if not impossible, to forecast with any great accuracy what the outcome will be. We will simply recite the facts as reported to us and note the various predictions as to what may happen, our purpose being primarily to project serious thinking on the part of members of the industry and to encourage an analysis of the present market picture in time to prevent what might become a serious situation.

Today DDT has found a very definite and important place in the insecticide picture, and it is the opinion of most industry spokesmen that there is every reason to believe that DDT will continue in volume use for the foreseeable future, even if other materials are introduced which may further supplement or substitute for it. It is the general belief that, based on the current real demand, the probable consumption here in the United States is of the order of 25 to 35 million pounds of DDT per year. To this must be added any increase in demand that may arise because of development of new uses (to be discussed later) and whatever new demands may arise as a result of current rehabilitation plans now being discussed by the State Department for Europe and Asia.

This latter factor may tend to increase consumption substantially, since during the calendar year 1946 it is estimated that over 7 million pounds DDT (in terms of technical) were bought by various Federal and foreign Government agencies for use in overseas relief and rehabilitation work. During the latter part of 1946 and thus far in 1947, the matter of exchange has seriously affected purchases of these materials directly by the foreign governments themselves or trade factors within the countries. It is quite conceivable that with the current relief program, however, demand for DDT may well equal or exceed any previous quantity shipped for these purposes. Exports may thus become an increasingly important factor in absorbing current excess DDT production.

With the supply of DDT, and productive capacity as well, currently in excess of demand, it is doubtful that within reason further decrease in price will bring about any greater demand. Where DDT insecticides are really effective, control is probably being secured more cheaply than it has ever before been achieved with other materials. Particularly in the agricultural field reduced prices seem to have but little effect in stimulating greater demand for materials. Of course, there are many fields where insect control has never been possible prior to DDT because of the economics, but many of these have already succumbed to control using DDT.

Another important factor in this connection is that with all insect

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control, and particularly in the agricultural field, the actual cost of the insecticide is but a small factor when compared to the expense of labor and time of application. Further possible reduction in the price of the insecticide would be but a minor factor in the total cost of the pest control job, and could logically be expected to have little effect in stimulating increased use.

With the advent of chlordane, chlorinated camphene, benzene hexachloride and similar chlorinated materials, the question has always been raised as to what effect these materials may have on the demand for DDT. Without attempting to evaluate each of these materials individually, work thus far has indicated that in general these newer materials in many cases supplement, rather than substitute, for DDT. For example, in cotton, benzene hexachloride and DDT combinations are already apparently proving effective, which opens an entire new field for DDT not existing prior to 1947.

In general it seems safe to predict that the newer insecticides, including the dimethoxy derivative of DDT, will probably never have any appreciable adverse affect on the volume of DDT to be used.

Some concern has been expressed recently that the residual hazards connected with the use of DDT around cows and dairies and the resultant finding of DDT in milk and in beef might result in reduced use in these fields. However, conversations with many authorities in this field have indicated that while there is currently some concern being expressed on this point, no drastic action need be anticipated, at least until certain chronic toxicity tests now underway are fully completed and evaluated. In this connection, there is increasing realization that many of the supplementary materials now being studied will not give the long lasting effectiveness against cattle and other insects that DDT does. It is possible that even if the use of DDT is somewhat curtailed, it will probably never mean complete stoppage of the use of DDT in these fields.

Effect of Normal Prices

THE further question is always raised that when prices are again somewhat more normal, the old standbys, such as the arsenicals, rotenone and pyrethrum will again take their former places in the insecticide picture, perhaps affecting seriously the consumption of DDT. With the recent decline in the price of DDT mentioned above, however, the price of rotenone and pyrethrum will have to drop considerably before they will again resume their normal place in pre-DDT days. Of course, these botanicals will always have their place in insect control, but DDT will undoubtedly prove an important supplement in many fields of use, and in turn these botanicals will still be a supplementary aid to DDT.

As far as the arsenicals are concerned—particularly in the case of lead arsenate, there has been a definite decline in the use of this material in the fruit field, but there continues a demand for certain uses. Based on present information, DDT has replaced lead arsenate about 45% (almost entirely in the fruit field), and there is the possibility that an additional 5% to 15% of the remaining market may be taken by DDT. Calcium arsenate seems to have suffered even more and aside from whatever use that it may have on cotton in view of some of the newer materials, DDT has replaced calcium arsenate almost entirely.

There has also been considerable discussion recently, particularly among those concerned with the control of fruit insects and household insects, as to the possibility of declining insect populations, which may have been brought about in part by DDT, having a permanent adverse effect upon future sales of insecticides. On the other hand, there are many who feel that it is weather that has brought about this decline in demand for insecticides, particularly during the 46 and 47 seasons, and not DDT at all. This is certainly not the place to discuss this matter exhaustively. However, if there has been a substantial and permanent decline in the insect population, it will obviously have an important effect on the use of DDT insecticides.

Work underway at the present time indicates that some of the more important insects attacking corn and cotton, two of the largest volume crops grown in the United States, are succumbing to DDT. If real control can be obtained by the use of DDT, these uses probably will mean a substantial increase in DDT consumption. In the field of forest and ornamental tree insects, DDT has but scratched the surface in 1946 and 1947. Most industry representatives are extremely optimistic for increased use of DDT in this field and point to the approximately 200 tons of technical DDT alone used in the "experimental" Tussock Moth control program in Idaho during this past summer.

Control of forage crop insects will also add to the use of DDT. However, information on possible residue problems will have an important bearing on the all out use of the material in this field.

The use of DDT in public health work such as "fly-free" campaigns, mosquito control projects and similar undertakings appears to have been exploited to a limited extent, but very probably there will be a more fertile field in this direction as the advantages of this type of project become more appreciated. Interest in this field of use has even more possibilities in view of the development of new and better methods of application.

In summary, it appears that there is not as yet the market for DDT that current productive capacity is capable of turning out, and that curtailment of production is necessarily in the offing. However, there should be no room for pessimism on the part of manufacturers of DDT and DDT-based insecticides, but rather a feeling of optimism—with promised expansion of present uses and the search for even newer uses promising an expanded future market. It has often been pointed out that the actual consumption of insecticides and fertilizers has but been scratched and this again is true in the case of DDT. The manufacturers of DDT and

(*Turn to Page* 67)

SEPTEMBER, 1947
SUBJECT: Results with DDT for the control of cabbage worms.
AREA: Iowa
One grower in this area, who marketed 4 million pounds of cabbage last year, used Du Pont "Deenate" DDT on his crop. This grower stated he obtained such complete worm control with "Deenate" DDT that he was able to guarantee his entire crop to be worm free.
SUBJECT: Results with DDT for control of sheep keds (ticks).
AREA: Utah
Specialists studying the sheep spraying program here report that an extra pound of wool can be sheared from the belly of each animal that has been treated with DDT. This is possible because the DDT controls sheep keds (ticks) and keeps the animals from rubbing on brush, which tears off the fleece.
These specialists also report that wool from sheep treated with DDT is of better quality than that from untreated animals.
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The Listening Post

Insect Conditions In Late July and Early August

This column, reviewing current insect control programs, is a regular feature of AGRICULTURAL CHEMICALS. Mr. Haeussler is in charge of Insect Pest Survey and Information, Agric. Research Adm., B. E. & P. Q., U.S.D.A. His observations are based on latest reports from collaborators in the department's country-wide pest surveys.

By G. J. Haeussler

THE middle of July saw the first weather conditions this summer generally unfavorable to development of the boll weevil. Hot, dry weather that occurred at that time and during the rest of July in most states aided greatly in checking the weevil. By early August the infestations had become very spotty in many areas. Some cotton fields were still practically free of weevils or the infestations were so low that the use of insecticides would not be profitable. Other fields in the same counties were heavily infested and required treatment. Data available shortly after the middle of July indicated that an estimated total of 36,400,000 pounds of calcium arsenate will be available for use this season. This is less than the amount used during a season of average infestation. The current season's supplies are going to areas where the need is greatest. They are expected to aid materially in meeting current *needs* but will not fully meet *demands* in those or in other areas where needs are less pressing.

Serious infestations of the bollworm were reported from Georgia, Alabama, Mississippi, and Louisana about the middle of July and lighter infestations were reported from most of the other cotton growing states. By the end of July this insect was still causing considerable damage in some sections of Alabama, in a few fields in Texas and eastern Oklahoma, and in Georgia especially in the Piedmont area.

Cotton leafworms were found in Refugio County, Texas on July 22 and in Burleson County on August 2. These are the third and fourth counties of Texas in which the insect has been reported this year, it having been found in Calhoun and Nueces Counties during June.

During the last half of July cotton aphid infestations were reported as rather serious or on the increase, especially where calcium arsenate or DDT has been used, in a number of states, including North Carolina, South Carolina, Georgia, Alabama, Tennessee, Lousiana, Arkansas, Texas, Oklahoma.

The Mexican bean beetle infestation continued moderate to heavy during the last half of July and early August in practically all of the territory in the south and also in a number of other areas including Maine, New Jersey, Delaware, Maryland, northwestern Tennessee, Nebraska, Wyoming, and Colorado. Lighter infestations were reported from New York, Ohio, and Utah.

During the last half of July the bean leaf beetle caused severe injury to beans in Louisiana and was reported in lighter numbers from Virginia and Tennessee. The potato leafhopper, which occurred in light infestations on beans in a number of states about the middle of July, appeared to increase in intensity later that month or in early August in several areas including New Jersey, Maryland, northeastern Tennessee, and Wisconsin.

Cabbage caterpillars continued abundant throughout the last half of July and early August on remaining cabbage and related crops in the South. Lighter infestations of these pests have continued to occur on cole crops during that period in Maine, New York, New Jersey, Tennessee. Ohio, California, Wisconsin, and Idaho.

Flea beetles were reported attacking broccoli in Maine and rutabaga in southern Idaho at the end of July, and infesting turnips and mustard in Alabama the first week in August.

A severe outbreak of the tomato fruitworm was reported from Spalding and Pike Counties in Georgia about the middle of July. This insect increased in abundance in the Atlantic Coastal region during the last half of July and early August.

Early in August the velvetbean caterpillar was reported from St. Mary, Terrebonne, Lafourche, Assumption, Ascension, Iberville, and West Baton Rouge Parishes, Louisiana. It caused severe ragging to considerable acreages of soy beans near Franklin in St. Mary Parish. It was also found in some numbers in Houston and Geneva Counties, Louisiana, and was attacking peanuts in Union County, Florida.

The fall armyworm was reported to be causing severe damage to pastures, lawns, corn, grasses, soy beans, alfalfa, peanuts, cotton, and sorghum in southeast Alabama, northwest Florida, and in northern counties of the Coastal Plain and southern counties of the Piedmont in Georgia. General infestations, particularly in late corn, also occurred in Mississippi. An armyworm was attacking pastures, corn, peanuts, and alfalfa in North and South Carolina early in August, and lawns, pastures, corn and peanuts a short distance north of Savannah, Georgia.

Aphids caused considerable injury to beans during the last half of July in many areas, including New York, New Jersey, Delaware, Maryland, Virginia, Alabama, Utah, Washington, Oregon, and California. They caused some damage to cabbage and related crops in New York, New Jersey, Maryland, Georgia, Wisconsin, Utah, the Palouse District of Idaho—Washington, and in Cali-

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Comparative studies of the effectiveness of various insecticides in controlling pests attacking tomatoes were conducted as part of a research program carried out last summer in California. The highest yields were obtained with a 5% RHOTHANE treatment . . . approximately 24.74 tons per acre. This compared with a yield of 21.96 tons with 3% DDT and 21.06 tons with 5% DDT.

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fornia. Light populations of the pea aphid continued to infest peas the last half of July in Maine, Wisconsin, and Minnesota. Insecticide applications were required to control this pest in one district of Utah, and the aphids were very abundant toward the end of July on late-planted peas in the Palouse District of Idaho-Washington. A limited outbreak of the potato aphid on tomato has occurred in New York, New Jersey, and Maryland, and it was also reported attacking that crop in the state of Utah.

The outbreak of the green peach aphid continued into early August on the top growth of unharvested tobacco in Florida and Georgia. Lesser infestations, though critical, have also occurred on tobacco in South Carolina, North Carolina, Tennessee, Maryland, Pennsylvania, Connecticut, and Massachusetts. In Connecticut, the potato aphid was abundant on broad leaf tobacco, while the green peach aphid predominated on shade-grown tobacco.

Tht Japanese beetle has been more abundant this year than it was in 1945 or 1946 in much of the generally infested area. It has caused moderately greater damage than last year in the District of Columbia. Damage observed late in July in neighboring Maryland and Virginia, and also in southern Pennsylvania, indicated a greatly increased beetle population in these areas. There appears to be little evidence of any spread over last year from that part of the generally infested area.

Slight increases of codling moth activity were reported from some sections in late July and early August, including eastern New York, southern portions of New Jersey, Indiana, and Illinois, western Kentucky, and Door County, Wisconsin.

The red-banded leaf roller has been reported from apple orchards in New York, western Kentucky, southern Indiana, and southern Illinois, but no serious damage has occurred.

Orchard infestations of the European red mite occurred in many areas, including New York, New Jersey, North Carolina, western Kentucky, western Tennessee, southern Indiana, and southern Illinois. Populations appeared to be on the increase in some areas early in August. The two-spotted mite was also on the increase at that time in southern Indiana, southern Illinois, and western Kentucky.★★

Current Plant Disease Condition in U. S.

This department, which reviews current plant disease and insect control problems, is a regular monthly feature of AGRICULTURAL CHEMICALS. The comments on current plant disease problems are based on observations submitted by collaborators of the Plant Disease Survey, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, Beltsville, Md.

By Paul R. Miller

RATHER general and in some regions serious development on tomato blight has taken place in central Atlantic and Ohio Valley areas. The disease on tomato has been reported as far north as Rhode Island and northwestern New York, and west to central and southern Indiana and western Tennessee. Infection on plants shipped from the south, which caused so much loss of young transplanted fields in the north last season, was not a factor at all this year.

Tobacco Blue Mold

BLUE mold had appeared as far north as Maryland when last mentioned (June issue). Occurrence in Pennsylvania, Connecticut, Massachusetts and Ontario has been reported since then. It is interesting that the first report in Massachusetts was on May 16, rather earlier than usual, whereas in Connecticut it was first found on June 3, about a month later than usual in spite of favorable cold wet weather. Systematic spraying with "Fermate" of over 90% of the Connecticut beds since the first week in May probably accounts for the late appearance there. In Massachusetts, too, 80 to 90% of the beds were sprayed. Notwithstanding favorable weather, no more primary infections were observed, and the season was one of the lightest experienced for blue mold damage.

In spite of the very destructive attack on tobacco flue-cured seed beds in Georgia, which was complicated with cold damage and caused at least 75% loss of plants, enough plants were left to set out practically all the allotted acreage. The disease was not severe in the cigar wrapper area.

Seedling Blight of Rice

FAILURE of rice stands in Arkansas and Texas was often reported during late spring of this year. In extreme cases as many as three sowings had been made in an effort to establish a stand. Most of the plantings in which the extreme losses occurred were made in March. The cold period extended throughout February, March, and even up to May in Arkansas, leaving the ground so cold that seedling emergence was slower than usual, and this no doubt contributed much to the failure to secure stands.

Blighted seedlings examined were attacked by species of *Fusarium* or *Aspergillus*. Many of the sprouts attacked by *Aspergillus* had hardly broken through the hulls.

Seedling treatment with fungicides such as "Cuprocide," "Arasan," and "Phygon" is recommended to avoid such seedling losses. The reluctance of growers to use these materials is largely due to personal irritation caused by the fungicides. It is to be hoped that "Arasan SF," which is used in water suspension (slurry treatment), will prove to be adapted for use on rice as this method avoids the irritation that is objectionable in the case of the dust disinfectants.

Other Difficulties

MANY farmers in the Shenandoah Valley counties of Virginia experience difficulty in keeping alfalfa stands productive longer than

(*Turn to Page* 68)

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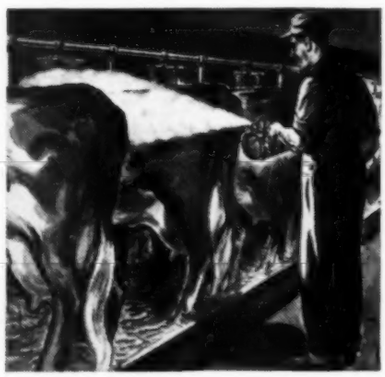

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Technical Briefs

Indian Derris

D. ferruginea, the only species of derris indigenous to India which contains good percentages of rotenone, was investigated chemically. Both rotenoid-bearing and nonbearing varieties were studied, the former yielding 4.3 percent of rotenone and a small quantity of dehydrorotenone, and the latter yielding no crystalline component. A comparison of rotenone-bearing *D. ferruginea* and *D. elliptica* showed that chemical differentiation was possible. Three crystalline substances were obtained from the chloroform extractives of the roots of *Derris scandens*. N. V. Subba Rao and T. R. Seshadri. *Proc. Indian Sci. 24A*, 344-8, 365-74.

•

Particle Size of Insecticide

That particle size is an important factor in determining deposit, distribution, and effectiveness of dusts and concentrated sprays is stated by Dr. S. F. Potts of the Bureau of Entomology and Plant Quarantine, U.S.D.A. in the *Journal of Economic Entomology* 39: (6): 716. His summary continues:

"A field of resistance surrounds all objects, including plants and insects, and repels most individual dust particles of small size, as well as droplets smaller than approximately 30 microns in diameter.

"Ordinary dust clouds consist of a mixture of individual particles and agglomerates of many particles attached together. If the particles are small, the deposit on insects and plants consists almost entirely of agglomerates.

"Dust particles may be coated in the air by small droplets of oil, if the mixing takes place either in a vacuum or under pressure.

"Fine atomization is necessary to obtain adequate distribution with low gallonage, but the droplets must be large enough to deposit on foliage and insects. Apparently for ground application most of the spray should be in droplets 30 to 80 microns in diameter. For aerial application most of the droplets should be 70 to 100 microns in diameter if the areas are large and flat, and as large as 100 to 300 microns for the control of certain forest insects on rugged terrain.

"The number of droplets of given size that would be deposited per unit area per gallon of liquid distributed on acre of surface is presented.

"Other factors affecting particle or droplet size are type of distributing device, concentration, density, and type of insecticide, rate of volatilization of the ingredients, distance to which the particles must be drifted, wind and other meteorological factors, volume and compactness of foliage, and settling rate."

•

Grasshopper Control

The perpetual threat of a grasshopper invasion has led South Dakota station entomologists at the Brookings station to the conclusion that if headway is ever to be made some cheap insecticide must be found that can be used as spray or dust, or both, to treat the edges of small grain and corn fields where young 'hoppers find openings to invade those fields.

This insecticide, says Dr. H. C. Severin, head of the entomology dept., "should be non-toxic to livestock and should remain effective for 2 or 3 weeks at least. Proper equipment must also be available to apply the material."

The closest approach to such an ideal insecticide, he declares, is "1068." Unfortunately, he adds, in the station's annual report, "1068" is toxic to livestock so must be applied under conditions where livestock cannot have access to the treated crop. This insecticide, he found, can be applied without burning the plants and, he says, "we have found that it does kill grasshoppers even though used in a spray at a strength as low as one-half pound per acre. At double this strength the kill is materially increased and the duration of time that the insecticide is lethal to grasshoppers is increased."

South Dakota's report also contains an interesting outline of the efforts made to protect the state's shelter belts from tree-destroying insect pests through use of various chemicals.

•

Chemical Weed Killers

Vermont Station at Burlington offers in its 1946 report a new argument in favor of chemical weed killers in that state. "The uneven topography of much of the land makes removal by machinery difficult," says the report. "Under such conditions spraying or dusting with chemicals offers a promising method of control."

•

Nicotine Test Report

In a preliminary report on toxicity tests with nicotinium salts, U.S.D.A. bulletin No. E-725 gives the following summary of results: the toxicity of 48 nicotinium salts to the melonworm (*Diaphania hyalinata* (L.)), the southern armyworm (*Prodenia eridania* (Cram.)), spider mites (*Tetranychus* spp.), and to certain other insects was investigated in a limited number of preliminary tests.

Methyl nicotinium iodide, dimethyl nicotinium diiodide, and dodecyl nicotinium *p*-toluenesulfonate were more toxic to insects used than nicotine sulfate, or nicotine, when tested on the basis of equal amounts of nicotine.

•

Cottonseed Tar Larvicide

"Gossypix," a mixture of 3 volumes of cottonseed tar with 1 volume of kerosene, is an efficient mosquito larvicide. The tar is a by-product of the destructive distillation of cottonseed in ginneries using producer gas. It is a somewhat viscous dark brown liquid readily miscible with kerosene. In laboratory and field tests, it proved equal in efficiency to commercial larvicidal oils and the cost was estimated at about one-half. The chief disadvantages are the difficulty of preparation and limited availability. G. H. E. Hopkins, *East African Med. J. 20*, 41-5.

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INPC on Quackgrass

Results of experiments of INPC (0 Isopropyl-N-Phenyl Carbamate) on quackgrass grown under greenhouse conditions and in the field indicated that at 5, 15, 30 and 60 pounds per acre, the material would kill the weed. The experiments are reported by John W. Mitchell, Sr. Physiologist and L. W. Kephart, Sr. Agronomist at the U.S.D.A. Plant Industry station, Beltsville, Md. Their conclusions state that on the basis of experiments, well-established quackgrass plants, whether those developing directly from seed or from stolons, are sufficiently sensitive to the INPC to warrant more extensive study.

Tests have shown that quackgrass is most sensitive to INPC when the material is applied to the roots, rather than to leaves or stems. Before application, rank leaf growth is removed so that the chemical falls on the soil rather than on the plant leaves. Thus far, sand has been the most effective carrier. Being heavy, it carries most of the chemical down to the soil surface.

"In experimenting with INPC under field conditions," the summary continues, "care should be taken in applying it to soil which may be needed for growing grass crops at a later date. It is known that INPC is inactivated in the presence of moist soil and that the rate of inactivation appears to be about the same as for 2,4-D under similar conditions. Factors that govern this rate of inactivation, on the other hand, are not at present known, so care should be exercised in the application of this chemical until its behavior in the soil is better known.

"Confirming early English observations, it has been noted that broad-leaved plants including sugar beets and some weeds have shown no signs of injury in greenhouse tests or in the field where the chemical was applied to the soil. Much more information is needed, however, before this chemical can be recommended for use near broad-leaved crop plants.

"INPC has been used experimentally over a period of several years without toxic effects on persons who have handled the compound. It should be handled with reasonable care, however, until more is known concerning any toxic effects it may have on humans or animals."

•

1946 Fungicide Tests

Phytopathological Society. Mimeographed. 29 *pp.*

This second annual report sponsored by the Potomac Division of the American Phytopathological Society summarizes the results on some 117 different fungicides as obtained and reported by over 150 professional workers in the United States and Canada on many kinds of plants, seeds and soils. The results reported are necessarily of a preliminary nature and do not constitute recommendation of any sort. Nevertheless, the information is of timely value to the experimental plant pathologist and to the industrialist in planning current programs of field evaluation.

The results obtained for the different fungicides are summarized for given diseases of the fruit, vegetable, and field crop and ornamental plants on which the fungicides were tested. Also included is soil sterilization and fumigation and seed treatments.

A few fungicides were selected for special mention as regards their usefulness. Thus the dithiocarbamate fungicides continue to give good results in many fields. Tetramethylthiuramdisulfide ("Arasan") was promising as a seed treatment for corn, flax, forage crop, peanuts, sorghum, sugar beets, and most vegetables. Ferric dimethyldithiocarbamate ("Fermate") was probably the best all around organic fungicide for fruit diseases, giving good results on apple scab and rust, avocado rots, cherry leaf spot, cranberry Guignardia rot, grape black rot, raspberry anthracnose and also rose black spot when combined with sulfur. In general, "Fermate" was not promising on vegetables though good on a few specific diseases. The zinc salt ("Zerlate"), however, was promising on a number of vegetable diseases, including early and late blights of celery, and early blights of tomato, and potato, but not late blight. Sodium ethylenebisdithiocarbamate ("Dithane D 14") + zinc sulphate-lime and the reaction product zinc ethylenebisdithiocarbamate ("Dupont IN 5446," "Dithane Z 78") give favorable results on early and late blights of celery, potato and tomato and certain other diseases, but for still other vegetable diseases, these were not satisfactory. "IN 5446" and "D 14" were injurious on cucurbits.

Tetrachlorobenzoquinone ("Spergon") was satisfactory for treating seed of corn, certain forage crops, peanuts, sorghum, and certain vegetables. Dichloronapthoquinone ("Phygon") appears to have rather wide application, being promising for apple seed and rust, cherry leaf spot, peach brown rot, early and late blights of celery, potato and tomato and some other vegetable diseases. It was also promising as a seed treatment for sugar beets, corn, vegetables and other seeds. "Phygon," however, is handicapped by being injurious in some cases to potato, tomato, cucurbits, cabbage and apples.

Phenyl mercury triethanol ammonium lactate ("Puratized Agricultural Spray N5E") in a severe apple scab year gave good results and appears to eradicate without host injury, but should not be used with lime. It is seemingly safe with lead arsenate and DDT. However, the mercury content prohibits its use after the first cover spray. It was injurious to various shade trees and not promising for vegetables in general.

Zinc trichlorophenate ("Dow 9 B") was promising for treating gladioulus dry rot and yellows, and seed of cotton, peanuts and corn, while ethyl mercury toluene sulfoanilide ("Dupont 1452") was favorable for treating seeds of barley, cotton, flax, rots, sorghum and wheat.

The quaternary ammonium compounds, lauryl isoquinolinium bromide ("Isothan G 15") and lauryl pyridinium bromide ("Isothan Q 4") in general were not promising. The former was injurious on maples and oaks.

—*S.E.A. McCallan*

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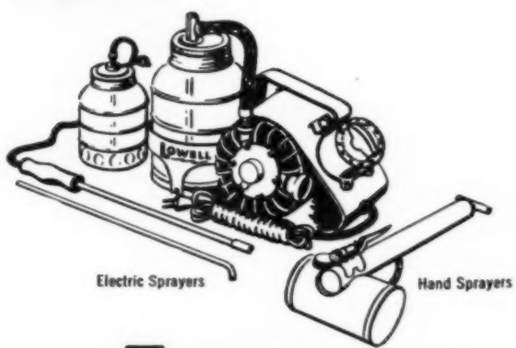
Give your insecticide . . . liquid or powder the merchandising "push" that outstrips competition. Double its saleability with Lowell Sprayers and Dusters—the name your customers associate with quality . . . the products that ensure results. Don't be "insecticide-wise and sprayer-foolish." Write Lowell now for information on how Lowell Sprayers and Dusters can boost sales for you!



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WORLD'S LARGEST MANUFACTURER OF SPRAYERS AND DUSTERS EXCLUSIVELY

Suppliers' Bulletins

Chlordane Information

Julius Hyman & Co., Denver, Colorado, have recently released a number of bulletins covering their Chlordane product, "Octa-Klor." These include the following: Technical Bulletin No. 1, a summary of chlordane's effectiveness on various insects, and information on dosages and applications.

Technical supplement No. 201 describes control of grasshoppers, lygus bugs, and alfalfa weevils with chlordane formulations.

Technical supplement No. 202 describes control of ants with chlordane, and No. 203 discusses control of livestock parasites. General circular No. 101 contains brief facts of general interest concerning chlordane.

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Carbide and Carbon Booklet

Carbide & Carbon Chemicals Corp., New York, has issued a revised edition of the booklet, "Physical Properties of Synthetic Organic Chemicals." The booklet, designated as form 6136, contains data on applications and physical properties for more than 175 synthetic organic chemicals. The material is presented in tabular form for quick reference. Copies are available from the company's office, 30 E. 42nd St., New York 17.

•

Insecticice Laws Described

A new and complete compilation of laws, comprising a 550 page loose-leaf volume, has just been issued by the National Association of Insecticide & Disinfectant Manufacturers according to an announcement by H. W. Hamilton of the Koppers Company, NAIDM secretary. The new book contains the text of all state and federal laws covering household and agricultural insecticides, fungicides, disinfectants, herbicides, rodenticides and allied caustic poisons with regulations, interpretations and explanations.

Labeling, registration, fees and other requirements are also covered in full. A chart showing at a glance the basic requirements of each state and a list of all enforcement offices is also included. Additions and corrections will be issued annually. The new book is bound in leatherette, five-ring loose-leaf, with page size 6x9. The work has been two years in preparation under the direction of John Conner, Washington attorney and general counsel for NAIDM. A limited number of copies of the new compilation will be available to firms outside of the NAIDM membership.

•

"H-4" Insecticide Booklet

Charles Edwards Chemical Corp., Philadelphia, has issued a booklet on "H-4," new emulsion concentrate insecticide. The booklet gives the results of standard entomological tests with the insecticide. Available also is a chart showing the suggested dilutions of "H-4" for use against various kinds of insects, with information regarding the percentage of kill within a 24 hour period. Address of the Charles Edwards Corp. is 1011 Diamond St., Philadelphia 22.

•

Reports on Various Materials

The Agricultural Experiment Station of the University of Maryland has recently issued an official report of studies covering agricultural insecticide and fungicide materials. Scores of charts are presented, showing the name of the material used, name of its manufacturer, difference, if any, between guaranteed and actual content of active ingredients, and comments upon the results. Copies in limited supply are available from the State Inspection and Regulatory Service, College Park, Md.

•

DDT Effectiveness Described

"Farm Research," quarterly bulletin issued by the New York State Agricultural Experiment Station, Geneva, presents in its July issue an informative article by L. A. Carruth entitled "How Useful is DDT?" The article contains a comprehensive chart showing the performance of DDT against fruit and vegetable insects in New York State, including information on the degree of control, danger of injury to plants, and the residue problem from DDT. Photographs of various insects attacking fruits, vegetables, and plant foliage accompany the charts.

•

"Rhothane" for Earworm

The Rohm & Haas *Reporter* for July, 1947, carries an article on control of corn earworm, and recommends "Rhothane" for the control of both ear worm and corn borer. Indirect attacks on the insects have proved ineffective, the article says, but many direct methods also have their shortcomings because of toxic residues in some cases, and lack of killing power in others. DDT, while effective in controlling the pests, makes the feeding of fodder a questionable practice.

"Rhothane" (DDD) the article states, was used in New Jersey for corn ear worm control. Tests made in 1945 and 1946 showed the product capable of controlling both ear worm and corn borer infestations. "On the early sweet corn tests, experimental materials used included arsenicals, DDT, 'Rhothane' and other types of organic insecticides," the article says. "Applications of the dusts were made by hand duster on some plots, by machine duster on others, and by airplane on still others. Both 'Rhothane' and DDT gave far better control of earworm than the other materials used, but 'Rhothane' showed substantial superiority over DDT dust on the basis of percent of control."

Since these New Jersey tests were completed, numerous others in various parts of the country have been under way. Large-scale tests comparing DDT and DDD were made with "Rhothane" used as a three percent dust in a talc diluent and DDT at five percent in a similar carrier. "In these tests, 'Rhothane' was found decidedly superior to DDT."

SANTOBANE

(MONSANTO DDT)

The grape leafhopper is another of the many agricultural pests successfully controlled with proper formulations containing Santobane — Monsanto's DDT. It is preferred by many manufacturers of insecticides because it is a uniform, free-flowing, granular material that can be easily solubilized, emulsified or milled.

Santobane is available to meet your requirements.

Inquiries concerning the properties, formulation and uses of Santobane will be given prompt attention. MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 1700 South Second Street, St. Louis 4, Missouri.

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INDUSTRY NEWS

New Fertilizer Plant Begun

Construction work on a new $350,000 fertilizer plant was to begin in Tulsa, Oklahoma in August, according to the Missouri Chemical Co., Joplin, Mo., which, in cooperation with the Ozark Chemical Division of the Ozark-Mahoning Co. of Tulsa is building the new plant. The unit will have a capacity of 100,000 tons annually, and expects to produce a minimum of 50,000 tons during the first year of operation. The new concern, named the Oklahoma Chemical Company, is wholly owned by officials of the Missouri firm. The Ozark company enters the picture through its function of supplying sulfuric acid for the manufacturing process. Output of the plant will be distributed in Oklahoma, southern Kansas and northwest Arkansas.

•

Monsanto Lowers DDT Price

Monsanto Chemical Co., St. Louis, has announced a reduction of 5¢ per pound for DDT, marketed under its trade name, "Santobane." The reduction marks the initial operation of new facilities at Monsanto, Illinois. New prices are 37½¢ per pound for minimum car-lots and over; 40¢ per pound for lots of 2,000 pounds (both prices inclusive of 100 pound fiber drums); 43¢ per pound for less than 2,000 pounds in fiber drums; 48¢ per pound for less than standard containers, f.o.b. Monsanto, Ill. The company has been manufacturing DDT at its Queeny plant in St. Louis since 1944, but lower costs are anticipated at the Illinois plant.

•

Porter to Innis-Speiden

Innis, Speiden & Co., 117 Liberty St., New York, announce the appointment of Richard P. Porter as head of soil fumigation sales and research. He was formerly with the W. Atlee Burpee Co., Philadelphia. Mr. Porter is a graduate of the University of Connecticut and is a member of the American Phytopathological Society. In addition to his other duties at Innis, Speiden & Co., he also directs the company's long-range

RICHARD P. PORTER

program in soil fumigation at Boyce Thompson Institute, Yonkers, N. Y.

•

Coming Meetings

Agricultural Chemicals wishes to publish the meeting date and place of any gathering concerned with manufacturing, distribution, application or discussion of chemicals for agricultural use. Information of such meetings is solicited.

American Chemical Society, Sept. 15-19, New York.

Association of Economic Poisons Control Officials, Shoreham Hotel, Washington, D. C., October 19, 1947.

15th Annual Convention National Pest Control Association, Bellevue-Stratford Hotel, Philadelphia, October 27, 28, 29.

Pacific Chemical Exposition October 21-25, San Francisco.

National Fertilizer Association Fall Meeting: Atlanta, Ga., Nov. 10, 11, 12.

American Association of Economic Entomologists (In conjunction with meeting of American Association for Advancement of Science.) December 26-31, Congress Hotel, Chicago, Ill.

Exposition of Chemical Industries New York, December, 1947.

Annual Convention, American Association of Economic Entomologists, Congress Hotel, Chicago, December 27-30.

N.P.C.A. Plans Oct. Meeting

The future of the pest control industry will receive prime consideration at the annual convention of the National Pest Control Association to be held at Philadelphia, October 27, 28 and 29. Speakers representing various portions of the country, and others from experiment stations, the U.S.D.A., and manufacturing firms are scheduled to appear. Among those expected to be on the program are Dr. J. J. Davis of the Entomology Department of Purdue University, Lafayette, Ind.; S. A. Rohwer of the Bureau of Entomology & Plant Quarantine, U.S.D.A.; and Dr. Charles E. Palm of the Department of Entomology, Cornell University, Ithaca, N. Y. Dr. Palm will discuss possibilities of pest control outside of walled spaces, in agricultural and horticultural fields. E. R. Jennings, New York, is general chairman of the N.P.C.A. The meeting will be held at the Bellevue-Stratford Hotel in Philadelphia.

•

Maine Bans L. I. Potatoes

The state of Maine, through an executive order by Gov. H. A. Hildreth, has placed a ban on the importation of all potatoes grown in Nassau County, Long Island. This quarantine was invoked to prevent possible spread of Golden Nematode to the Maine potato-growing area, although the only portion of land known to be infested on Long Island is already under strict quarantine.

Governor Hildreth's proclamation followed a recommendation by E. L. Newdick, chief of the Maine Agriculture Department's plant industry division. The states of Vermont and New Hampshire have also declared an embargo on Nassau County potatoes, in an effort to prevent the introduction of Golden Nematode into their potato growing areas. Growers in these sections are keeping a watchful eye for evidence of an infestation.

CSC

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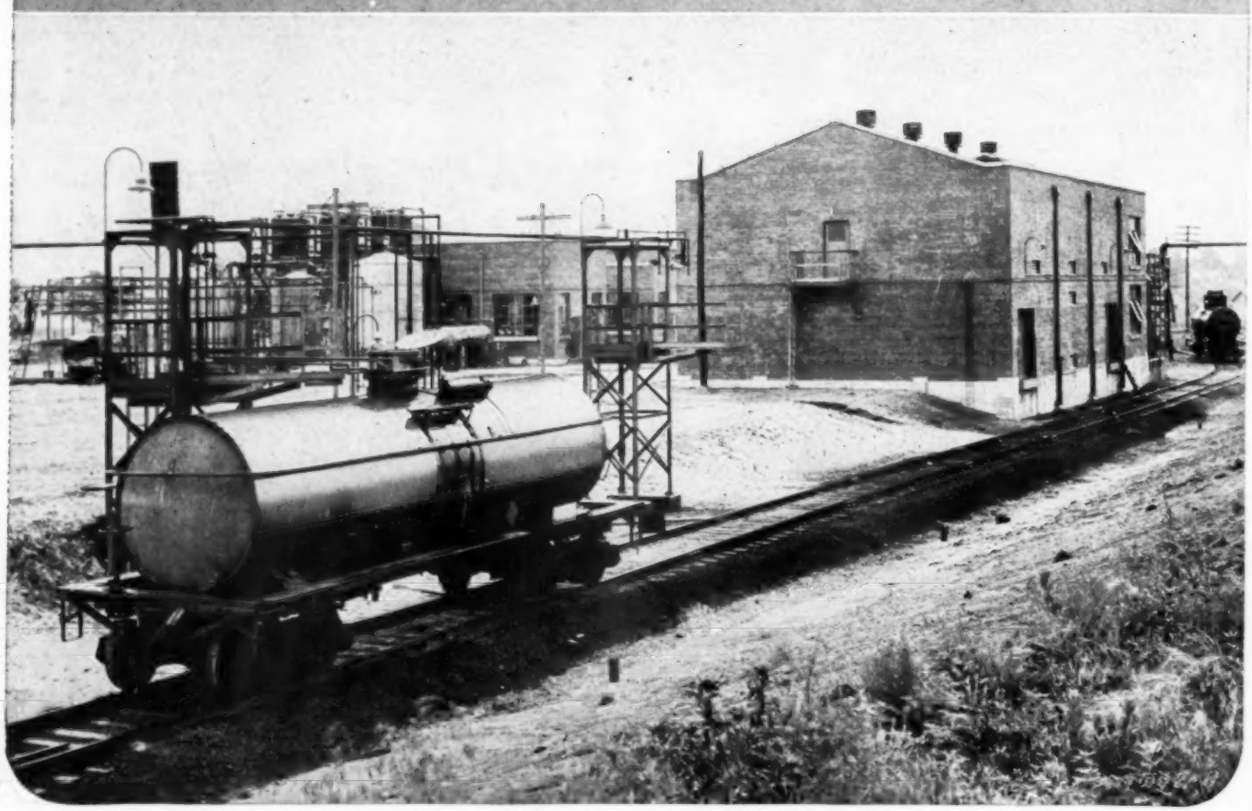

At Terre Haute, Indiana, a new Commercial Solvents plant is now producing technical-grade benzene hexachloride—*of uniform gamma, minimum odor, and high kill.*

☆ CSC Benzene Hexachloride is available in multiple drum lots to major insecticide manufacturers.

Please address inquiries to New York.

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Fertilizer Plants Rushed

The Spanish Government has requested an acceleration in completing two new fertilizer plants in Madrid, according to dispatches from there. The manufacturers being urged to speed up are Sefanitro and Nitratos de Castilla. National consumption of food in Spain has outstripped the nation's imports, a fact which makes imperative the necessity for more fertilizer.

•

"INPC" Tests Being Made

Although still very much in the experimental stage, the new weed killer, "INPC" (Isopropyl-N-Phenylcarbamate) has indicated its possible use for control of grassy weeds unharmed by 2,4-D. Undergoing extensive tests at the U.S.D.A. Plant Industry Station, Beltsville, Md., under the supervision of Drs. John W. Mitchell, Paul C. Marth and L. W. Kephart, the material is reported to inhibit the emergence of a number of narrow-leafed grasses upon application to the surface of the soil. Experiments both in the field and under greenhouse conditions show that well-established first-year quackgrass plants grown from seed and other quackgrass plants developed from well-established stolons were killed by INPC.

Problems in connection with proper concentrations, and methods of application are among the principal obstacles in perfecting the material for commercial use. One method of application is to mix from 10 to 80 pounds of INPC with sand and spread it over each acre treated. Other experiments are contemplated by which the crystalline powder may be made soluble in water for easier application.

Action of INPC differs from that of 2,4-D in that the former affects the plant primarily from absorption through the roots. Consequently, applications to the soil surface have been more effective than application to the leaves. A number of chemical manufacturers are manufacturing INPC in limited quantities. J. T. Baker Chemical Company, Phillipsburg, N. J., who supplied INPC for the Beltsville experiments, is possibly further advanced in INPC manufacture than a number of other firms entering the field. Spokesmen for the Baker Company emphasized the fact that INPC is entirely experimental, and that much is yet to be learned of its action and use.

Attapulgus Clay Company has moved into its new research laboratory at Airport Circle, Camden, N. J. Space in the new laboratory is almost three times greater than in the former building, the company says. Both basic research and control work will be done in the new building on the firm's products: fullers earths and activated bauxites. In addition to the laboratory proper, the building contains extensive office space a storage area, and a reference library.

•

New Sulfur Co. Formed

W. Mercer Rowe

Flag Sulphur and Chemical Co., Tampa, Florida, has announced its recent acquisition of the former Schnarrs, Inc., facilities at Tampa. The new firm will engage in sulfur grinding, and will manufacture and market various types of insecticides, fungicides and weed killers.

W. Mercer Rowe, formerly assistant sales manager of the Agricultural Chemical Division of Pennsylvania Salt Mfg. Co., is in charge of operations as vice-president. Mr. Rowe has had long experience in the agricultural chemical field, having been with the Fertilizer and Chemical department of the Farmers Cooperative Exchange in Raleigh, N. C., for a number of years before joining Pennsylvania Salt Mfg. Co., Philadelphia.

GUEST EDITORIAL

(*Continued from Page* 19)

facturers of pesticides who can meet the challenge in the days ahead are those who can best service their customers with effective and reliable products, delivered when and where needed. The industry, dedicated as it is to serving the American farmer, will measure up to these tests in the future even better than in the past.

For agriculture, the benefits of a stronger pesticides industry will be measured in more and better products, and increasingly efficient distribution of these products. This increased service to agriculture will in turn be translated in terms of higher yields and improved quality of farm products for consumers and for industries which process or manufacture farm crops.

Time was when research into the causes and control of insects and diseases preying on farm crops and animals was largely restricted to Federal and State agricultural agencies. The industry joins with the farmer and with the public in paying tribute to those agencies for the contributions they have made and are making to agricultural pest control.

Improved legislation affecting the manufacture and distribution of

VETERINARY SUPPLY HOUSES

Whether under actual use or subjected to the most rigid scientific tests, Baird & McGuire's CRESTALL FLUID comes through with flying colors.

Known for its thoroughness, high quality and uniformity, this disinfectant fills a very important need of the veterinarian, the veterinary hospital or for general farm use.

Available under private brand labels or in bulk quantities, veterinary supply houses are invited to write for prices, full details and samples.

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CRESTALL FLUID

Approved By The
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For official disinfection of cattle cars, trucks, boats or other premises harboring cattle or livestock.

agricultural insecticides and fungicides is also adding strength to the industry. A case in point is the Federal Insecticide, Fungicide and Rodenticide Act, signed into law by President Truman June 25. In a similar category is the uniform State Economic Poisons Bill, drafted by the Council of State Governments, and since January 1 enacted, substantially as drafted, in nine States.

New legislation was needed because the Federal Act of 1910 was outmoded. The 1947 act recognizes the introduction of new and powerful insecticides, of rodenticides, and of new weed killers. Its provisions will give greater protection to the public from misbranded or adulterated products—an objective with which the industry is in accord and which it has long sought to achieve.

Also contributing to the strength of the industry is the Agricultural Insecticide and Fungicide Association. Its members produce and distribute more than 80 percent of the pesticides purchased by the American farmer, rancher and gardener. Industry-wide problems bearing on service to the American farmer are the Association's special concern and the record makes clear that the AIFA has made outstanding contributions to the development of a strong industry.

Illustrative of a forward-looking AIFA activity is the promotion of a program to enlarge and intensify pest surveys. Insects cost the American farmer an estimated two billion dollars a year. Plant diseases cost another two to four billion dollars annually. These losses would be measurably greater were it not for the farmer's use of the products of our industry. Yet the fact remains that only a small part of the crop acreage in this country is sprayed or dusted—a mere eighth of the total land in crop production.

In conclusion, there is reason to be optimistic in appraising the future of the industry. The war years created problems without precedent. The challenge to the industry, at a time when food and fibre ranked with tanks and ammunition in importance, was the greatest it ever faced. Industry met its responsibilities; the American farmer received the pesticides vital to the achievement of his production goals. The days ahead will bring fresh problems, larger responsibilities—and new opportunities. Industry will meet them; the farmer will receive improved products and better service.

PLANT FOOD IN U. S.

(*Continued from Page 41*)

The Tennessee Valley Program started in 1935 with the distribution of 6,170 tons of P_2O_5. This gradually increased to 15,600 tons in 1940 and 19,000 tons in 1946. Since 1943 the annual program also has included about 3,000 tons of N and small amounts of potash.

Potash

Potash production figures, like those for nitrogen and P_2O_5, are on a different basis than those for the other categories in the tables. They include production for the chemical

(*Turn to Page 65*)

8 HYDROXY QUINOLINE BENZOATE

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An Emulsifier of Petroleum Oils

Economical - Effective

MUL-SI-MO is especially adapted for the rapid emulsification of Oils whose viscosity is 120 Saybolt or less.

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Oils with a viscosity of 120 Saybolt or less cover the great majority of oils used in Dormant and Summer Sprays.

GENERAL TEXTURE
Mul-si-mo is a thin amber-colored oily liquid about the same viscosity as Kerosene Oil.

METHOD OF USE
There is nothing complicated about the use of *Mul-si-mo*. It is just poured into the oil to be treated at the rate of ½ to 1%, depending upon the tightness of emulsion desired—then thoroughly stirred—and the process is completed.

RESULT OF MIXING AS ABOVE
A practically 100% Oil Product— No Water— No Soap— No Potash nor other Alkalines.

NEUTRAL PRODUCT
Mul-si-mo is Neutral. Mul-si-mo-Made Emulsions are not adversely affected by pronounced saline, alkaline or acid re-acting waters.

ECONOMICAL TO USE —LOW COST
Mul-si-mo, we believe, is the cheapest and most economical Emulsifier on the market for the emulsification of the oils above specified.

NON-TOXIC TO PLANTS
Extensive tests have shown *Mul-si-mo* to be non-toxic to plants when used at a dilution of 1 to 100. (Plants used in tests—Coleus.) As summer oils are usually used at the dilution of half-gal. to 100 gals. water, at such dilution the rate of *Mul-si-mo* to water would be 1 to 20.

COST OF MUL-SI-MO
Per Gallon $4.00; 5 Gallons and up @ $3.75 per Gallon; 50 Gallon Drums @ $3.50 per Gallon, f.ob. New York or Jersey City.

MUL-SI-MO SAMPLES
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Insecticide Diluent

Frianite M3x is the product which you read about when a dust carrier is chosen to make an insecticide better. Reference lists on request.

Check these features

1. Super-fineness of 98% minus 325 mesh.
2. pH range of 5.4 to 6.5.
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Frianite M3x is shipped direct from the mines and factory at Friant, California, in 100-lb. paper bags. Its many superior qualities make it economical to ship anywhere in the United States.

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Traffic . . .

SEVERAL freight increases already have been granted.

Further increases, and elimination of commodity rates and exceptions, have been suggested.

These make the work of the AIF Association's Traffic Committee increasingly important.

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Agricultural Insecticide & Fungicide Association

285 Madison Ave. **New York 17, N. Y.**

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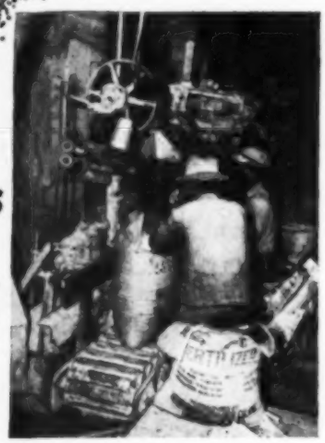
DUST is a nuisance that costs money!



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Roto-Clone saves both ***space*** and ***money***, as a single unit performs the functions of exhauster and dust collector. And Roto-Clone is easy to install, as it is shop-assembled and tested before shipment.

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Specialties Dept.
230 Park Avenue · New York 17, N. Y.

industry as well as for agriculture. They do not, however, contain the K_2O content of wood ashes, tobacco stems, cement mill dust and some other materials used as commercial fertilizers. About 5 percent of the total consumption, or 18,000 tons of K_2O, was used in chemical industry in 1930. In 1940 about 36,000 tons and in 1945 about 85,000 tons were thus used. The K_2O content of organics, ashes, etc. used as fertilizers has averaged about 20,000 tons annually in the past 15 years.

The U. S. production of K_2O in the form of soluble salts increased more than 15-fold, or from 61 to 941 thousand tons in 16 years. In 1930 production was only one-sixth of consumption. On the other hand in 1946 production exceeded the combined needs of agriculture and industry and provided 46,000 tons for export. In 1930 the net imports of K_2O were 312,170 tons. In 1940 net imports were reduced to 59,405 tons. In every year since, the exports exceeded the imports of fertilizer potash by 37,000 tons or more.

U. S. consumption of fertilizer potash in 1946 was more than double that of any prewar year, except 1937, and the 1937 figure was barely over the half way mark. The Soil Conservation Program included 21,375 tons of K_2O in 1936 and 59,739 tons in 1945. There were substantial quantities in all of the intervening years except 1944.

Total Plant Food

Table 4 summarizes the total available plant food situation for the United States from 1930 to 1946, inclusive. Although twice as much plant food was consumed in the latter years three times as much was produced. Exports were nearly trebled and imports were cut in half. Column 6 shows that whereas only 70 percent of the plant food consumed in 1930 was produced in the United States, in 1946 nearly as much was produced as was consumed and in 1947 production probably will exceed consumption. The proportion of the production exported has varied from 5 to 13 percent and in recent years it was about the same proportion as in the beginning of the period. Formerly one-third of our plant food was imported. In recent years imports were only about 10 percent of the total consumed.

In interpreting the tables it should be kept in mind that only a few of the years given could be considered normal years. This will be apparent from Figure 1, which shows that consumption in the years 1932 to 1935 was well below the normal trend owing to the depression and that for the years since 1940 it was much above the trend line owing to the war and the Agricultural Conservation Program.

The trend curve plotted in Figure 1 was calculated by least squares from the actual consumption of plant food by decades from 1840 to 1900 and annually from 1901 to 1941, inclusive. It indicates the prewar trend in growth of fertilizer consumption. The extrapolated part of the curve from 1941 to 1946 shows the consumption that would have been expected on the basis of past

(*Turn to Page 67*)

A Standard Carrier for Insecticidal and Fungicidal Dust

EMT CO. 23

TALC

This grade of talc has proper and efficient bulking characteristics

SOFT flaky particles which enhance stickiness.

COMPATIBILITY with all insecticides.

SOFTNESS which eliminates abrasion in dusting machine nozzels.

FINENESS — The proper fineness for complete coverage, determined by Entomologists.

UNIFORMITY of all qualities guaranteed by the largest manufacturer of the greatest variety of talcs in the world.

Working samples furnished free

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VERMONT

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DOW

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Many farmers of today advance production—add to profits—through increased use of scientifically developed chemical aids. The Dow Chemical Company has been a primary source of such chemicals for many years. Its growing line of agricultural chemicals have been thoroughly tested in laboratories and in the field to insure dependable performance.

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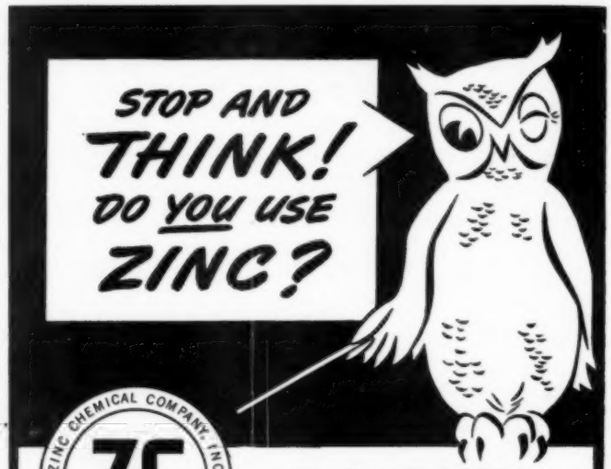

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the *Quality* Zinc Sulphate for Crop Protection

Now available for use in your fungicide and soil treatment programs. Contact your County Agent or Experiment Station for recommendations on the use of this material in your area; and always specify Z-C Brand when purchasing Zinc Sulphate from your dealer!

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PHELPS DODGE REFINING CORPORATION
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KAOLIN CLAYS

VELVEX and TYPE 41

For use in extending DDT and other insecticidal materials

APPROVED by entomologists, these clays have also met with general acceptance by mixers and blenders of agricultural insecticides.

- NON-ABRASIVE
- SMALL PARTICLE SIZE
- CHEMICALLY ADAPTABLE
- GOOD ADHESIVE QUALITIES

For information and samples, write:

SOUTHEASTERN CLAY COMPANY

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Hold Insecticide Hearings

Advertising not to come under new federal law enforcement by USDA . . . statement by H. E. Reed . . . 50 attend Washington session . . . opposition to specific colors for poison powders . . . suggest clarification of toxicity definitions . . . W. G. Reed presides . . .

WASHINGTON, D. C.,—At a public hearing on the proposed regulations covering enforcement of the new Federal Insecticide Law held here on August 25, Harry E. Reed, Director of the Livestock Branch, Production and Marketing Administration, U. S. Department of Agriculture, read a statement which in practical effect divorced advertising of insecticides, fungicides and other economic poisons from the jurisdiction of the new law. Although, he stated, the law might be interpreted to include all advertising copy as well as labeling claims of economic poisons under USDA jurisdiction, the matter of advertising as covered in the Federal Trade Commission Act would be left for the attention of the FTC to avoid conflicts and overlapping of the laws.

This statement in effect was taken to mean by those attending the hearing that the USDA will not undertake to police insecticide, fungicide, and allied advertising. Following the statement by Mr. Reed, Lea Hitchner, executive secretary of the Agricultural Insecticide & Fungicide Association, stated that he disagreed with Mr. Reed that the legislative intent was to include advertising under the act and desired to enter this exception in the record. John Conner, general counsel for the National Association of Insecticide & Disinfectant Manufacturers entered the same exception.

The hearings on the proposed regulations were attended by some fifty representatives of industry and government. W. G. Reed, Chief, Insecticide Division, Livestock Branch, USDA, (not to be confused with Harry Reed, the Director) presided. He also announced that his division had extended the time during which industry and others may file written suggestions for changes in the regulations until September 8th. It is believed that the completed regulations will be issued shortly thereafter.

Liaison with F.T.C.

W. G. Reed issued a brief statement covering the matter of Insecticide Division policy in regard to insecticide and fungicide advertising copy which stated in part:

'It will be the policy to cooperate with other agencies of the Government to insure that this Act will be administered in a manner to result in reducing to the absolute minimum any possibility of conflict with or overlapping of the administration of other Acts. (1) In furtherance of this policy there has been established a liaison, which is now in operation, for constant cooperation and coordination between the Federal Trade Commission and the Department of Agriculture in the enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act and the Federal Trade Commission Act as they apply to economic poisons. (2) In general, the policy will be for advertising, other than labeling, to be handled as in the past by the Federal Trade Commission. (3) In the application of the above policy it is to be understood, however, that both agencies reserve the right to the full use of their respective powers when such use is necessary to protect the public interest."

Suggested changes in wording of regulations, of definitions, and clarification of words were made by numerous representatives of industry and other interested persons. Regarding economic poisons highly toxic to man, Dr. A. G. Cranch, of Carbide & Carbon Chemicals Corp., stated that the present wording, "significant number of deaths" is confusing, and not specific. He suggested that the wording should include such phraseology as "When death results in half the number of tested laboratory animals," which is another way of expressing the standard "LD50." In the section covering "serious impairment of health," he said it should read "toxic by inhalation, 200 milligrams per kilogram of body weight." He suggested further that some understanding should be had as to the kind of animal or animals to be subjected to these toxic tests, since different species vary in susceptibility to given poisons.

Dr. E. J. Lehman of the Food and Drug Administration agreed that the "LD 50" wording would be satisfactory, but added that a surprising number of persons did not know the meaning of the term. Consequently he favored the terminology of "half of tested animals" as suggested by Dr. Cranch earlier. Dr. Lehman

indicated that in the matter of inhalation, 100 parts per million would include most toxic compounds and would serve the purpose of the act. The same was true with skin toxicity, he said. The "200 mg per Kilo" he thought a little high, and suggested its reduction to 100 mg per K. The reason for this, he said, was because some of the newer insecticides such as chlorinated hydrocarbons possess properties which indicate that they penetrate human skin.

Chairman Reed asked for comment regarding the understanding of what is meant by "any common laboratory animal," and Dr. Lehman answered by stating that in most tests a number of animals are used . . . often as many as five species since their reactions are so different to some materials. He said that not only are rats used, but dogs, cats, rabbits, guinea pigs, etc.

Warning Words Discussed

IN discussing the regulations covering warning and caution statements, J. D. Conner of NAIDM suggested that the word "required" be changed to "necessary," and that the word "the" should become "a" to precede warning. N. F. Crass, Assistant Secretary of the Manufacturing Chemists Association, indicated that the signal words, "danger," "caution," "warning" or "poison" should be based on the over-all properties of the material. He said that "danger" should be reserved for hazards of extremely serious nature, and the other words in progressive mildness. Wm. G. Buettner of the National Pest Control Association stated that the words, "Danger" and "Warning," should not be used because they frighten housewives unduly, and might have the effect of seriously reducing the market for retail packages thus labeled. Mr. Conner of the N.A.I.D.M. urged that all regulations covering the specific use of such words be eliminated from the regulations.

Strong opposition to requirements for specific coloring of white powdered insecticides was offered in the discussion on coloration. Dr. E. J. Lehman of FDA was asked for an opinion by Chairman Reed and proposed that white powders be blended to a dirty grey color by use of carbon black as probably the most practical type of coloration from the safety angle. This proposal was backed by William Buettner of the NPCA who held that specific tinting of white powders was impractical. S. A. Rohwer, Assistant Chief of the Bureau of Entomology & Plant Quarantine from whom Mr. Reed also requested an opinion, urged that much study should be given to coloration and that everybody should go very slowly in specifying definite colors.

Whose Name on Label?

SPEAKING in opposition to the requirement that the name of the actual manufacturer of the product must appear on the label of an economic poison, Dr. George Fiero of Stanco, Inc. stated that whatever name appeared on the package should be that of the registrant irrespective of whether he be the actual manufacturer or not. He opposed the use of the terms, "Packed for . . . ," Distributed by . . . ," etc. and held that only the name of the registrant should appear on the label without any modifying phase. He stated that the responsibility of

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New Sales Manager for Baker

H. B. Rasmussen, formerly general sales manager of the Chicago office of J. T. Baker Chemical Company, has now taken up his new duties as sales manager of the Laboratory Chemical Division of the company at Phillipsburg, N. J.

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Pennsalt BHC Plant Produces

The Natrona, Pa., plant of Pennsylvania Salt Manufacturing Co. is now producing benzene hexachloride with a strength of 33 to 36 percent gamma isomer. The new manufacturing unit is expected to expand production of BHC to a large extent. The technical product is used to formulate the company's products D-10 and D-5, dust base items; and W-10, wettable base product used as a suspension spray. The BHC will also be used in emulsion concentrate, a water miscible solution with 9 percent gamma isomer; and solvent concentrate, with 9 percent gamma isomer for the manufacture of oil base sprays. High concentration of 33 to 36 percent gamma isomer is of advantage in formulating insecticidal products, the makers say. Under these circumstances, it is possible to produce an end product containing 10 percent gamma isomer, 20 percent inert BHC, and 70 percent diluent. This provides dust and spray bases with preferred qualities for agricultural applications.

Poison Control Officials Meet

The first annual meeting of the Association of Economic Poisons Control Officials is scheduled to be held October 19, 1947, at the Shoreham Hotel, Washington, D. C. Representatives from many sections of the U. S. are expected to attend, and plans for the program are practically complete.

•

A.I.F. Wins National Award

The Agricultural Insecticide and Fungicide Association has been awarded second place in the John N. Van der Vries awards, national competition among large trade associations. Basis of the prize was the A.I.F.'s obtaining revision and

the product and label are those of the registrant and no other person. John Conner, general counsel of NAIDM, supported the contention of Dr. Fiero.

Wide discussion arose over the inconvenience to larger chemical manufacturers shipping tonnage chemicals in bulk which might have use as economic poisons in addition to other uses. It was pointed out that such basic chemicals usually used in further compounding or processing do not go to the general public and in reality are not shipped by the original manufacturer as economic poisons. Representatives of several of the larger basic chemical manufacturers offered the suggestion that these materials be considered as exempt from the law under such conditions.

Discussing the statement of ingredients, Gilbert S. McInerny of Boyle-Midway, Inc. questioned co-chairman Dr. E. L. Griffin of the U.S.D.A. why the regulations forbade the use of trademarks or trade names for ingredients of a given insecticidal product. Dr. Griffin replied that often a number of other products are marketed under the same trade name, other trade names are completely fanciful, and that trade names frequently become generic.

Objections were raised against certain provisions for making shipments of insecticidal material to be used for experimental purposes. Lea S. Hitchner said that broader exemptions are needed, as well as a liberalization of the definition of economic poisons. He indicated that research activities would suffer from such a rule since various toxic materials must of necessity be transported to many parts of the country.

Noted in Washington....

At the hearings on the new regulations for the Federal Insecticide, Fungicide and Rodenticide Act, all the big shots were there . . . quite a gathering . . . about 50 . . . hot as hell in Washington but . . . ah . . . that nice air-cooled auditorium where the hearings were held!

* * * * *

W. G. Reed makes a very efficient presiding officer. With a soft kid glove, he avoids sharp clashes of opinion and speeds up the actual work accomplished. A really businesslike government hearing if we ever saw one.

* * * * *

Coming out of the meeting for a quick smoke, we ran into Phil Groggins on his way in.

* * * * *

Lea Hitchner, AIFA band-leader, showed up with a bad cold, but it did not cramp his style a bit.

* * * * *

Big doin's in Washington in October! Oct. 18, Model Fertilizer Bill Committee meets at the Shoreham Hotel. Also on the 18th and the 19th, the Assn. of Economic Poison Control Officials meets. Luncheon honoring Dr. A. J. Cox and Dr. C. C. McDonnell at the Shoreham on the 19th. Also, Oct. 20-22, the Assn. of Official Agricultural Chemists meets in Washington. Also, on Oct. 21, the American Fertilizer Control Officials meet.

* * * * *

If you don't like any part of the new insecticide and fungicide regulations, you have until Sept. 8 to file further suggestions. Don't say we didn't warn you!

* * * * *

And Red Rohwer,—S. A. Rohwer to you,—was there. And so was Dr. Annand, BE & PQ chief! Not to mention Harry Reed, big chief of the Livestock Division.

* * * * *

Armour & Company plans to build a new 2 million dollar superphosphate plant at Bartow, Florida, near the phoshate rock mines owned by the comany.

* * * * *

St. Regis Paper Company has also announced that it will build a 6 million dollar Kraft mill and Multiwall bag plant at Tacoma, Wash., near one of its large pulp mills.

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standardization of state laws affecting the sale of insecticides, fungicides, rodenticides and other economic poisons. The awards were made by Earl O. Shreve, president of the Chamber of Commerce of the United States, at the National Institute for Commercial and Trade Executives, which operates as a summer school at Northwestern University, Evanston, Illinois.

•

Pathologists Meet in Ohio

Plant pathologists from 18 states, as well as representatives of the U. S. Department of Agriculture attended the summer meeting and tour of the Upper Mississippi Valley Plant Pathologists at Wooster, Ohio, August 6 to 9. The tour, consisting of an inspection trip through the plant disease control experiments at the Station and in northern Ohio, began August 6 and continued through the 9th.

The final three days of the meeting included exhibitions by producers of fungicidal and insecticidal materials, an innovation for this type of meeting. Firms represented at the meeting included R. T. Vanderbilt Co., Monsanto Chemical Co., Sherwin-Williams Co., Rohm & Haas Co., Homestead Valve Mfg., Diamond Fertilizer Co., Harshaw Chemical Co., Loomis Talc Co., Geigy Co., Dow Chemical Co., Shell Oil Co., Michigan Chemical Co., Standard Oil Co., Phelps Dodge Refining Corp., Floridin Co., Bean Mfg. Co., Naco Mfg. Co., Carbide & Carbon Chemicals, Linde Air Products, Tennessee Copper Co., H. J. Heinz Co., Niagara Sprayer & Chemical Co., F. E. Myers & Bros., DuPont Co., Goodrich Chemical Co., Pittsburgh Plate Glass Co., California Spray Chemical Co., Crop Protection Institute, Crop Saver Co., Gibsonburg Coal & Ice Co., Pecatonica Airplane Dusting Service, U. S. Rubber Co., California Packing Co., and the Mellon Institute, Manganese Research, Farm Bureau, and the Battelle Institute.

Raw Material Markets . .

REFLECTING the catching up of production with demand for DDT, one major producer has recently announced a reduction of 5c per pound, bringing the price to 37½c per pound in car load lots. The downward trend in DDT prices is perhaps the most spectacular development in the insecticide industry of recent weeks, and is causing manufacturers to calculate whether the present estimated U. S. consumption of DDT, from 25 to 35 million pounds per year, can be expanded to make an outlet for the tremendous manufacturing capacity which is approaching the point of 100 million pounds per year. Heavy exporting of DDT, new uses, and exanded control programs are seen as helpful factors to steady the market.

In contrast with DDT, copper sulfate has "tightened up somewhat," according to industry spokesmen. customers are obliged to "shop around" to get certain types of crystals. Whereas growers earlier in the season used synthetic fungicides to control various types of mild plant diseases, the development of late blight has precipitated a heavy demand for copper to control the spread of the disease. The industry has had to resume production on certain types of copper recently to supply the brisk demand. Ordinarily, at this time of year, these facilities are closed down for the season, one spokesman said.

The pyrethrum supply situation remains relatively the same, with stocks adequate. No change in price has been noted, although the East African Pyrethrum Board some weeks ago advised the Kenya growers to accept a lower price for their produce because of the abundance of insecticidal materials in the U. S.

Production of fertilizer material shows a consistent increase, and tag sales for July set an all-time record, according to National Fertilizer Association figures. Sales in the 11 southern states amounted to 209,000 tons, an increase of 0.4 percent over the preceding July, 49 percent over July 1945, and 480 percent over the average for the years 1935 to 1939. Tag sales in 16 states were unusually high; the July volume of 417,000 short tons being an increase of 797 percent over the average of the past years. Despite the July record, however, the tag sales for the period of January through July were 2 percent below the seven-month corresponding period of 1946.

Production of superphosphate for the fiscal year ending in June, was higher than 1946 output. The 9,506,000 short tons (Basis 18 percent A.P.A.) was 13 percent greater than the 8,430,000 tons produced during the 1945-46 fiscal year. In line with this report is the June record of 802,000 tons of superphosphate compared with 643,000 tons of June last year. Added production is attributable to the establishment of numerous plants, large and small, in various parts of the country, and by high output from already-established factories. Increased use of fertilizer materials by midwestern growers, plus an apparently growing demand on the part of farmers to purchase fertilizer supplies early in the year contributed to the added sales.

The American Potash Institute reports new records in deliveries of K_2O during the fiscal year of June, 1946 through May, 1947. During that time 975,948 tons of K_2O were delivered, an increase of 7 percent over the previous corresponding period. Deliveries were made in 45 states and a few other countries. Georgia was the leading state for deliveries, with 74,975 tons.

•

Weed Killer Booklets

Naugatuck Chemical Division of U. S. Rubber Co., New York, has issued a number of pamphlets on 2,4-D weed killer. One, describing the action of "Tufor" and "Tufor-Tabs," formulations of 2, 4-D. Directions are given for use on lawns, and warning is given regarding use near various ornamental plants. Another booklet presents a chart which translates percentages of 2, 4-D powder or liquid into pounds and various liquid measures, as needed in certain dosages per acre. Instructions for application in weed control are also given in the booklet. This information is available from U. S. Rubber, Naugatuck Chemical Div., Rockefeller Center, New York 20, N. Y.

•

Dow Sales Hit New High

Dow Chemical Co., Midland, Michigan, reports an all-time sales record during the fiscal year which ended May 31, 1947. Consolidated sales amounted to $130,426,838, which was 28 percent above the previous year, and approximately 4½% above the wartime peak. This announcement is made in the firm's 50th annual report to stockholders.

•

F. W. Berk Co. Wrecked

A loss of more than $50,000 resulting from an explosion and fire, was suffered last month by F. W. Berk & Co., Inc., Wood Ridge, N. J. The firm which manufactures mercurial products lost its complete plant.

•

St. Regis Names Manager

St. Regis Paper Company has announced the appointment of Francis G. La Fave to the managership of its Watertown, N. Y., multiwall paper bag plant. Mr. LaFave joined St. Regis in 1935. A year ago he became night superintendent of the bag plant. In his new capacity, he replaces Budd E. Simonton who transferred to Oswego to become bag plant manager.

•

Elects New Vice-President

Michigan Chemical Corp., St. Louis, Mich., has elected R. A. Bondurant, Jr., a vice-president of the corporation. He has served the company since 1943 as technical director. The new vice-president is a graduate of Virginia Polytechnic Institute.

performance. The excess of actual consumption over the expected is explained largely by the emergency conditions resulting from the war and expanded conservation programs.★★

BIOASSAY of FUNGICIDES

(*Continued from Page 34*)

determine priority of interest and general background information. They do not necessarily eliminate chemicals and must be supplemented by the more elaborate methods using growing plants and seeds where expectations can be greater. Most investigators working with these more specific methods have demonstrated, at least in part, that promising chemicals also give more or less promising results in the field application. However, even in these cases small but very important field differences cannot be shown too clearly. The tremendous interest in new chemicals especially organic compounds which tend to be specific, demonstrate the need for the continued development of specific methods of bioassay. It is impossible for a single laboratory to carry many methods and so it will be necessary to have methods representative of the more important groups of diseases (26) or in special cases of a disease of unusual interest.

Summary

MUCH progress has been made in bioassay of fungicides in the last decade, largely because of demand for rapid assessment of new chemicals, and use of statistical procedures. Statistical interpretation has brought out such important relations as the dosage response curve, distribution of populations, errors of techniques, experimental designs, and necessary significant differences. Most laboratory methods appropriately have attempted to assay protectant value. Interest in standardization is emphasizing such methods as the slide germination with its attendant fund of basic information. Various developments have stressed precision apparatus for applying the chemicals. The more complex relation of fungus, host plant and chemical is receiving more attention by the development of greenhouse methods.

Bioassay lacks consistency within itself and with field results. The former disadvantage is being eliminated and while the second is more difficult its reduction is essential. At present emphasis should be less on increasing the precision of a given method and more on the development of appropriate methods to assess the specificity of new compounds and thus increase our source of practical fungicides and basic knowledge of fungicidal action.★★

Dr. McCallan's extensive bibliography will appear in the October issue of AGRICULTURAL CHEMICALS.

DDT OUTLOOK

(*Continued from Page 45*)

DDT insecticides must launch a widespread educational and promotional campaign to increase the demand for and consumption of insecticides in general and DDT in particular.

At Your Service

Coincidental with the celebration of our 25th year of service to the agricultural and industrial chemical trade, we announce the opening of our new warehouse and plant at Hicksville, Long Island.

Almost 40,000 square feet of well planned storage space enables the maintenance of adequate stocks of all materials. Direct railroad siding and ample platform facilities for truck deliveries and pick-up assure speedy handling and dispatch of all orders. A special department for repacking into small containers of materials heretofore available only in bulk is designed to satisfy a long-felt need of many customers.

Adequately staffed with experienced personnel aided by modern loading equipment, these new facilities will enable us to satisfy every reasonable demand of the clientele which we service in the New England and Middle Atlantic States.

Micro Nu-Cop

For the control of Potato and Tomato Blight. A fixed neutral insoluble Tri-basic Copper Sulphate containing 53% metallic copper for dusting or spraying. No lime required—extremely fine particle size, 2-5 microns.

●

AVAILABLE
From One Source

A complete list of agricultural products for the dealer backed by a quarter century of experience in serving the industry:

INSECTICIDES — SEED PROTECTANTS
FUNGICIDES — FERTILIZERS
FEED STUFFS — WEED KILLERS
And Allied Materials

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220 East 42nd Street, New York 17, N. Y.
Phone: MU 2-4848 — Cable: Trufabest
Plant and Warehouse: HICKSVILLE, L. I.

All of this educational effort must be coupled with the stark realization by management that the "honeymoon" is over on DDT and production must be within reason. Approaching the problem in this logical fashion, the outlook should not be "dark."★★

LISTENING POST

(*Continued from Page 49*)

three years. This situation has discouraged many growers from increasing their acreage of alfalfa. Good stands are usually secured the first year, but they thin out about the third year, thus making alfalfa growing an expensive procedure as the cost of the seed is so high. The problem of maintaining stands longer than three years appears to be a complex one. Some of the troubles are doubtless caused by insufficient fertilization, which predisposes the alfalfa plants to various diseases. It seems that the soil and fertilizer specialists, plant pathologists, physiologists, and agronomists could well work together in trying to solve this important problem.★★

HAVE YOU TRIED THIS TIME-TESTED ALL-PURPOSE TEAR GAS FUMIGANT?

Larvacide

KILLS RODENTS
Light dosage drives rats out of retreats to die on the open floor. No carcass nuisance. Easy, economical control in warehouses, burrows, farms, food plants, etc., is assured by over-night fumigation with Larvacide.

KILLS MOST SOIL PESTS
Larvacide controls most nematodes, wilts, soil insects, root rots, damping off and weed seeds. Applied a week or ten days before planting.

KILLS WAREHOUSE PESTS
Ideal for industrial fumigation. Controls flour moth grain beetle, drug store beetle, etc. Larvacide gets into cracks, crevices, inside seeds. Kills larvae and egglife as well as adult insects.

SEE ISCO Headquarters for Soil Fumigation.

LARVACIDE Easily applied with your own equipment or on contract application. Equipment available for large and small jobs. Larvacide is recommended particularly for greenhouse, sunbed and compost soil.

ISCOBROME Controls most nematodes, soil insects and many soil fungi, without danger to living plants nearby. Ideal for greenhouse use—permits safe planting in 4 to 5 days.

ISCOBROME D Best bet for low-cost field treatment to control nematodes and wireworms. No equipment corrosion or high flash point. Easy to apply with small applicators or with large field rigs.

Write today for full information on these Isco products.

ISCO

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BOSTON CHICAGO CINCINNATI CLEVELAND OMAHA PHILADELPHIA

SOIL INSECTICIDES

(*Continued from Page 23*)

(1945) [17,18] mentions its use as a soil insecticide, although no details are given. The British have used the gamma isomer as a seed treatment, have drilled the crude material into the seed beds at the time of planting, and have raked it into the soil. For wireworm control they have used it in the range of 2 to 5 pounds per acre prepared as a coarsely ground dust on available diluents such as chalk, applied as a 2 per cent dust at the rate of 100 pounds or more per acre.[1] In the United States, Pepper, et al (1946)[19] found it very effective for wireworm control when broadcast on the ground and disced into the soil. They received excellent protection to potatoes with no residual unpleasant odor or taste to the potatoes. Greenwood (1946)[2] reported similar results for wireworm control in potato land using as little as 0.2 pound gamma isomer per acre, applied as a dust and disced into the soil. In California the writer's experience indicates that the material is very effective on wireworms affecting lettuce and sugar beets in the Salinas and Sacramento valleys, using 1.5 to 2 pounds of gamma isomer per acre applied as a dust and disced into the soil. It is also effective in hydrocarbon solvents drilled into the soil at 12 inch spacings using 1 pound of gamma isomer per acre. As a seed treatment preliminary experiments indicate that 2 per cent (of total weight of seed) of the micronized 10 per cent gamma isomer material sprayed onto sugar beet seed will give protection from wireworms and garden centipedes. This same dosage on lima beans severely injured the plants and delayed germination of peas, although as a dry powder it is not a toxic. A mixture of dichloropropane-dichloropropene with hexachlorocyclohexane was found effective in controlling wireworms. In California the material is also being combined as a dust or spray with DDT for wireworm control. The effect of this chemical on

nodulation, and on other microorganisms is not fully determined.

DDT As Soil Treatment

DDT as a soil treatment is known for several insects. Jones (1945)[20] reports it for the control of pear thrips, and Wallace (1945)[21] for black beetles. Chisholm, et al (1946)[22] used an emulsion containing ethylene dibromide, DDT, and an emulsifying agent, for the control of Japanese beetle. White (1946)[23] reports experiments on wireworm control using DDT as a 10 per cent DDT-pyrophyllite mixture where it remained effective as long as 18 months in the soil. DDT is slow in acting for wireworm control and for this reason has not proven too satisfactory as a seed treatment. In experiments on wireworms affecting lettuce in the Salinas Valley in California the present writer finds DDT at the rate of 200 pounds of 10 per cent DDT powder not as effective after 5 months as 2 pounds of gamma isomer hexachlorocyclohexane dust (5 per cent gamma isomer dust.) DDT in aromatic solvents, drilled into the soil as ethylene dibromide was found ineffective in controlling wireworms. Commercial applications are being made during 1947 in southern California using approximately 1 pound of actual gamma isomer hexachlorocyclohexane, and 10 pounds technical grade DDT. The materials are used as wettable powders, sprayed on the surface, then disced into the soil. Usually 100 gallons of spray is applied per acre. Wilson and Choudhri (1946)[24] found that the application of DDT to the soil in excess of that which will ever be applied to the soil for insect control, had no effect on microorganisms, and did not seriously modify ammonification, the accumulation of nitrate, and the normal concentration of salts in the soil. That DDT may cause a depressing effect on nodulation of leguminous plants when applied to growing plants is pointed out by List and Payne (1947).[25]

Chlordane

This new chlorinated hydrocarbon, $C_{10}H_6Cl_8$, in preliminary tests in California was found by the writer to be very effective for the control of wireworms when used at the rate of 10 pounds of technical grade Chlordane in 20 gallons solvent (such as benzene) per acre. The material was drilled into the soil to a depth of 6 inches using 12 inch spacings in the same manner as ethylene dibromide.

In addition to those materials discussed there are a host of new chemicals both volatile and non-volatile which offer hopes for an economical control of soil infesting pests. It will take years of experimenting before the full effects of these chemicals are known on specific organisms, the effects on specific plants, and the reasons for the so-called "stimulation" due perhaps to partial sterilization of the soil or a change in the biota of the soil. The fumigant—residual type of application would seem to offer innumerable possibilities for the control of soil-dwelling pests. Such mixtures would give "stimulation" due to partial sterilizing of the soil, and a residual action which would kill specific organisms over a period of time.★★

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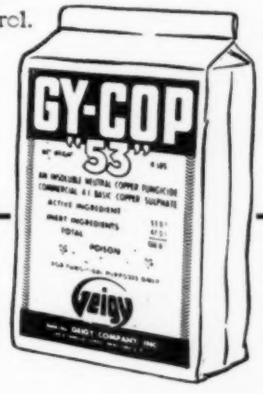

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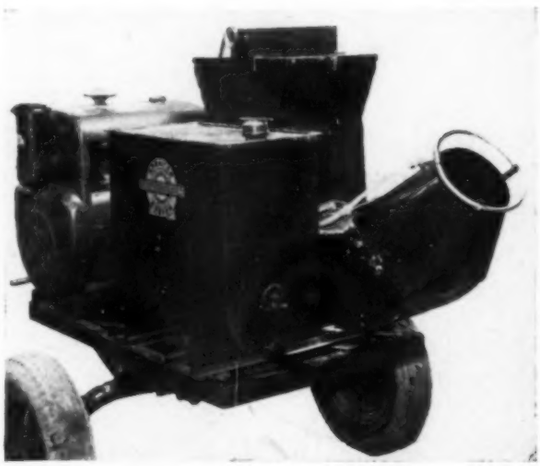

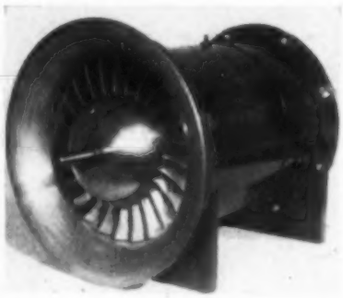

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INSECTICIDE PROBLEMS

(*Continued from Page 28*)

ranges to form an isomeric compound. It may be possible to develop this observation into an analytical method to differentiate the two or detect the one in the presence of the other.

Physical methods based on absorption spectra in the infrared or ultraviolet have also been suggested as possibilities for determining DDT. The method proposed by Herriott (18) for the *p,p'*-isomer is based on the fact that in ethanol solutions it absorbs light very slightly at a wave length of 250 millimicrons. After dehydrochlorination by dilute alcoholic sodium hydroxide the reaction product absorbs strongly at this wave length. The increase in absorption is measured and compared with the value obtained with a similarly treated standard solution. Downing et al. (19) have shown that infrared spectroscopy can be used for the chemical characterization of technical DDT, including detection of the several isomers and impurities and quantitative estimation of DDT content. Neither method appears to have had widespread application, partly perhaps because spectrophotometric instruments have not been readily available.

Although both chlordane and chlorinated camphene have been tested against a wide variety of insect pests, no specific chemical or physical methods for determining either have been published. As in the case of TDE and DDT, the total chlorine procedure can be used whenever it is known that no other chlorine-containing product is present. Not enough chemical information on either of these products is available to state whether or not the ratio of hydrolyzable chlorine to total chlorine can be used in their identification. Methods are also needed for the determination of the methoxy analog of DDT.

The methods of assaying benzene hexachloride that have been proposed may be divided into three broad classes—physical, chemical, and biological. The evaluation of this insecticide is complicated by the fact that the technical product is not a single pure compound but a mixture of isomeric compounds, usually four or five, together with small amounts of by-products such as the more highly chlorinated compounds heptachloro and octachloro cyclohexanes. By separating and testing the several components biologically it has been shown that the gamma isomer possesses outstanding insecticidal properties, the other isomers being of a much lower order of toxicity. Results against fourth-instar mosquito larvae are given in Table III.

As a result it has become the practice to evaluate benzene hexachloride in terms of the gamma-isomer content. It has also been reported, however, that the technical benzene hexachloride is more toxic to insects than would be predicted from its gamma-isomer content as determined by physical methods. These findings have led to statements that the other isomers exert a synergistic

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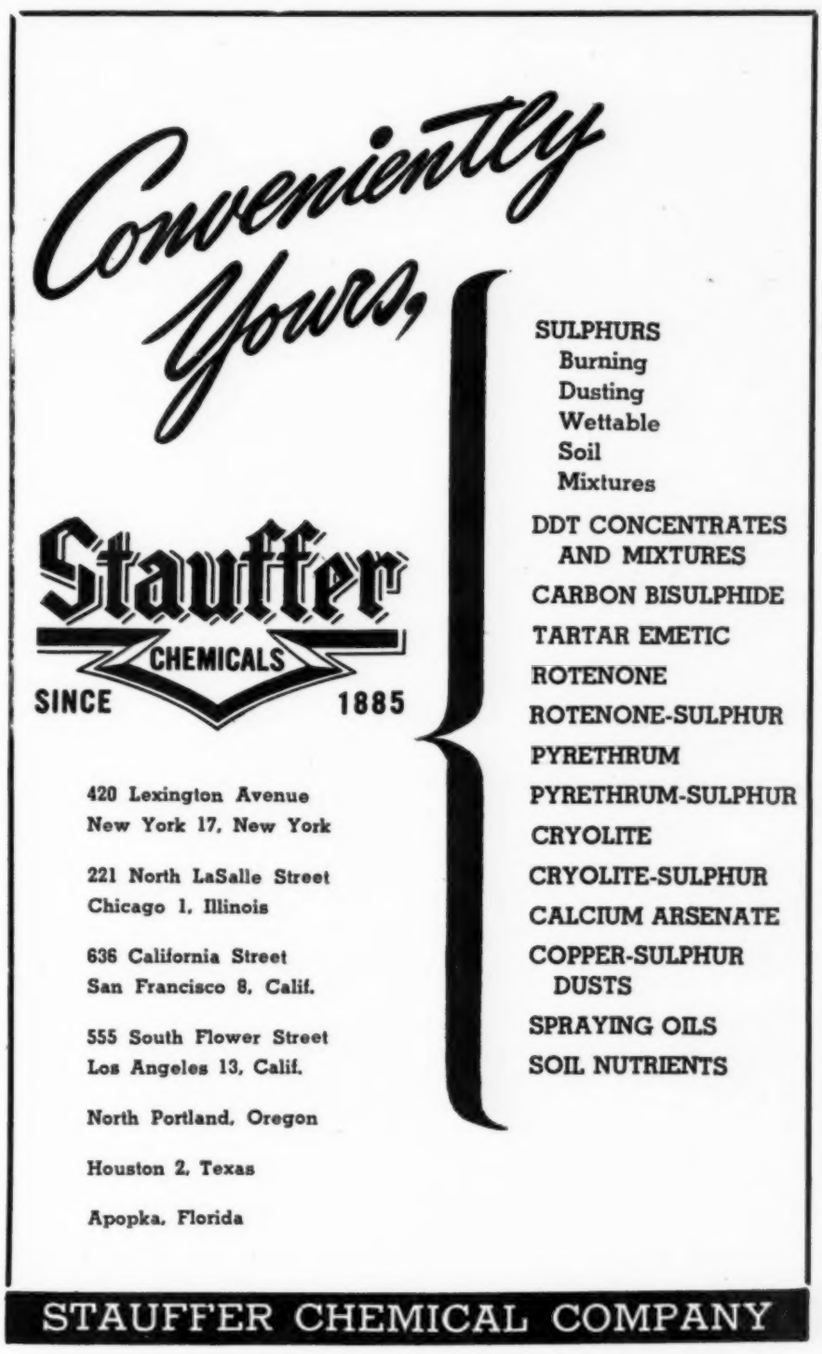
effect upon the gamma isomer, and the suggestion has been made that the insecticidal value of benzene hexachloride be expressed as "gamma equivalent." These statements are neither endorsed nor opposed by the present author. This value would be obtained by adding some figure, yet to be determined, to the gamma-isomer value as determined by chemical or physical methods. Before this can be done however, much more experimental work is needed, because each of the other isomers has a different degree of toxicity. That is, the concentration required to kill a given insect is not the same for each isomer and the proportions of the isomers in different lots of technical benzene hexachloride may vary widely, as will be seen in Table IV, which gives the composition of several lots of technical benzene hexachloride obtained from various sources in 1946. The analyses shown in the table were obtained by an infrared spectroscopic method and give values only for the known isomers of benzene hexachloride. Where the analysis does not total 100 per cent, the difference is due either to impurities or to unknown isomers of benzene hexachloride.

Comparative biological tests of the five isomers and of the gamma isomer mixed in various proportions with each of the others would therefore be of interest and should be carried out. However, because of the large number of possible combinations the experiments should be carefully planned. Because the alpha-isomer content is usually much greater than the content of any of the other isomers as is shown in Table IV, it appears to be desirable to begin the tests with it and the gamma isomer in various proportions against a number of different insects. Some results of laboratory studies that have been made against European corn borer larvae and against stored-grain insects are given in Tables V and VI.

From the data in Table VI it is evident that at the concentration used the gamma isomer is the only one that is materially toxic to the confused flour beetle when used alone. Of the combinations with the other three isomers, the gamma in combination with the beta isomer appears to be the most toxic.

LATE in March of this year technical representatives of industry and government held a conference at the Bureau of Entomology and Plant Quarantine, Washington, D. C., to consider methods of analysis of benzene hexachloride. The purpose of the conference was to enable technical workers to exchange information on methods of analysis of benzene hexachloride, with the objective of developing procedures to standardize determination of the constituents of the commercial product in the hope of standardizing materials in which it will be used for insecticidal purposes. Brief mention was made of the need of methods for determining total benzene hexachloride, its isomers, and by-products in spray residues, in pharmacological studies, and in admixture with other organic insecticides. The several methods that were considered are discussed below.

Methods based on physical



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measurements received most attention, largely because extensive and intensive studies had been carried out on infrared spectroscopic methods. Such methods have been used on technical benzene hexachloride, on the several isomers in pure form, and on some of the by-products of manufacture. The values reported in Table IV were obtained in this manner. From the information and observations that were freely exchanged, it appears that the infrared method is a useful one for determining the content of the gama-isomer, as well as that of other isomers of technical benzene hexachloride. The method is not readily applicable to mixtures of benzene hexachloride with other insecticides.

A cryoscopic method for the determination of gamma-benzene hexachloride has recently been developed by C. V. Bowen of the Bureau of Entomology and Plant Quarantine (unpublished). This method is based on the fact that the freezing point of a pure compound is lowered by the presence of dissolved impurities. The degree of the lowering, or depression, depends on the number of molecules of impurity present. Therefore, if 1 gram of a mixture of *A*, *B*, and *C* is dissolved in a known weight of the pure solvent, *X*, which is not a component of the mixture, it is possible to calculate from the depression produced in the freezing point of *X* the total number of moles (gram-molecular weights), *m*, in a gram of the mixture. If the same mixture is dissolved in pure *A*, the freezing-point depression gives the total number of moles per gram which is not *A*, i.e., *m* - *a*. Then *a*, the number of moles of *A* in 1 gram of the mixture, is readily obtained by difference. Theoretically, this method may be applied repeatedly for each component of the mixture, but a practical limit to its application is set by the difficulty of determining accurately a small difference between two large numbers. The method is therefore useful only for components present in substantial amounts. Application of the method for determining the *o,p'*-DDT and *p,p'*-DDT content of a solution of DDT in oil is given by Haller et al (5). A recent precise application of this method is described by Streiff and Rossini (20).

Several other physical methods as analytical tools for the gamma isomer have been studied. The pure isomers give well-defined X-ray diffraction patterns, but impurities in the technical grade interfere.

The polarograph has recently been suggested for the determination of the gamma isomer (21) This approach is based upon the observation that of the four isomers only the gamma isomer is reduced at the dropping mercury cathode.

Methods based on the determination of total chlorine and/or hydrolyzable chlorine were deemed to be of little value owing to their non-specifcity as well as to the fact that neither provided information on the gamma-isomer content. Total-chlorine determinations are useful in determining the presence of higher chlorinated products (heptachlorocyclohexane, etc.) in fractions obtained by various procedures.

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to determine benzene hexachloride by colorimetric methods. One of the proposals is to dehydrohalogenate the benzene hexachloride to the trichlorobenzenes, subject them to intensive nitration, and then convert the resulting nitro compounds into colored products with alkali.[2] The studies have not yet reached the stage where a quantitative procedure can be recommended. Ramsey and Patterson (22) have separated the isomers of technical benzene hexachloride by partition chromatography between nitromethane and hexane. This procedure may have possibilities as a quantitative method.

BIOLOGICAL assay is probably the most important evaluation of any product as in insecticide. However, in general, biological methods do not lend themselves to a high degree of accuracy, and frequently they require rather specialized technique and are time-consuming.

In laboratory studies to develop a biological method of determining the gamma-isomer content of benzene hexachloride, house flies and milkweed bugs (*Oncopeltus fasciatus* (Dall.) have been used as test insects. This method showed technical benzene hexachloride to be more toxic to both these insects than would be expected on the basis of its gamma-isomer content as determined by infrared spectroscopy and the known toxicity to them of the gamma isomer alone.

In a recent article Kirkwood and Phillips (23) showed that the gamma isomer possesses the ability, not shown by the other isomers, to inhibit the growth of a strain of yeast that requires inactive inositol for its growth. Although this observation has been proposed as the basis of a possible quantitative biological method for the gamma isomer, so far no procedure has been published for its use.

In summary it may be said that before the utility of an organic compound as an insecticide is established many problems requiring extensive studies need to be solved. Among them are a knowledge of the composition of the product, its solubility in various solvents, its compatibility with other insecticides, fungicides and dust diluents. Analytical methods, both chemical and biological for the product itself as well as in dusts, in sprays, and in combination with other insecticides must be developed. These and other related problems are the concern of both entomologist and chemist.

[2] Communication from H. J. Wichmann, U. S. Food and Drug Administration.

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The amazing new insecticide for control of Aphids, Spider Mites and many other insects.

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Industry Patents

The following patents have recently been issued by the U.S. Patent Office on products and devices in the agricultural chemical field. Copies of the patents may be obtained at 25c each by addressing the U.S. Patent Office, Washington 25, D.C.

2,423,284. INSECTICIDES. Patent issued July 1, 1947, to Francisco E. Babbini, Lima, Peru. An insecticidal composition which contains in intimate admixture, capsicum as an irritant agent, sabadilla seed as a source of toxic veratrine and methyl crotonic acid, and a member selected from the group consisting of the sulfate, carbonate and hydrate of lime as an activator, said composition being effective against Dysdercus, aphis, roaches, lice, fleas and the like.

2,423,619. Method of preparing copper fungicide solutions. Patent issued July 8, to Leo Roon, South Orange, N. J., assignor to Nuodex Products Co., Inc., Elizabeth, N. J. The method of making water-insoluble copper soap which comprises: reacting water-insoluble copper hydroxide, and copper carbonate, together with at least one substantially water-insoluble monobasic organic acid in the presence of aqueous ammonia, the copper raw material and the acid being present in stoichiometric quantities to produce an aqueous ammonical solution of a substantially water-insoluble copper soap.

2,423,794. Production of ammonium sulphate. Patent isued July 8 to Carl Otto, Manhasset, N. Y., assignor to Fuel Refining Corp., N. Y. In a process for producing ammonium sulfate which comprises passing ammonia-containing gas into contact with a bath liquor containing sulfuric acid, the improvement which consists in passing the gas beneath a surface which slopes downwardly, from the point at which it is brought in, at an angle of 4° to 15° to the horizontal, the lower edge of said surface being below the normal liquid level, so that the liquid surface beneath the sloping surface is depressed and agitated by said gas, the rate of gas flow being in excess of two cubic feet per second per inch of length of the discharge edge of said surface.

Trade Mark Applications

SKIL, in extra bold capital letters, for insecticides, germicides, disinfectants and deodorants. Filed April 12, 1946, by Gallowhur Chemical Corp., New York. Claims use since Jan. 23, 1946.

GAMTONE, in sans serif capital letters, for parasiticides—namely, insecticides, fungicides and fumigants, and animal repellents. Filled Oct. 18, 1946 by California Spray-Chemical Corp., Richmond, Calif. Claims use since September 18, 1946.

GAMMATONE, in sans serif capital letters, for same use as "Gamtone." Filed Oct. 18, 1946 by California Spray Chemical Corp., Richmond, Calif. Claims use since Sept. 18, 1946.

PEST-B-GONE' in sans-serif capital letters, for parasiticides — namely, insecticides and fungicides; animal repellents. Filed Oct. 30, 1945, by California Spray-Chemical Corp., Richmond, Calif. Claims use since July 27, 1933.

WDB-50, in heavy capital letters, for insecticides. Filed Dec. 1, 1945, by Pennsylvania Salt Manufacturing Co., Philadelphia. Claims use since July 26, 1945.

QUINOTONE, in thin capital letters, for chemical products for use as insecticides, fungicides, mildew-proofing agents, and preservatives. Filed Aug. 29, 1946, by Monsanto Chemical Co., St. Louis, Mo. Claims use since Aug. 10, 1946.

SUPER-TEX, in capital letters, for insecticides. Filed Aug. 9, 1946, by Tex Products, Inc., Newark, N. J. Claims use since July 12, 1946.

Applications Granted

431,051. PARASITICIDES, namely, insecticides, germicides and fungicides; Filed July 16, 1946, by Standard Oil Co. of California, San Francisco.

431,053. Chemical products for use in combating insects and fungi. Filed July 17, 1946, by Monsanto Chemical Co., St. Louis, Mo.

431,203. Fog generating machine for disseminating insecticides. Filed April 4, 1946, by Besler Corporation, Emeryville, Calif.

430,896. Mixture of ingredients for making insecticides and fungicides. Filed July 18, 1945, by Cooperative Seed & Farm Supply Service, Inc., Richmond, Va.

430,910. Liquid and Powder Insecticides and insect repellents. Filed Oct. 25, 1945, by Associated Products, Inc., Chicago, Ill., assignor to Harry Shapiro, doing business as Chemical Specialties Co., New York, N. Y.

430,946. Insect repellent and insecticide. Filed March 9, 1946, by Harry Shapiro, doing business as Chemical Specialties Co., New York.

430,966. Chemical weed exterminator. Filed Apr. 11, 1946, by Bay Chemical Co., Inc., Bay City, Mich.

430,982. Insecticides, fungicides, rodenticides and weed killers. Filed May 1, 1946, by American Cyanamid Co., New York .

431,005. Insect repellent in liquid form for use as a spray or by direct application to the affected area. Filed May 25, 1946, by Chandler Chemical Corp., New York.

431,010. Insecticides. Filed June 5, 1946, by Pennsylvania Salt Mfg. Co., Philadelphia.

431,012. Insecticides in liquid, spray and dust form and ant poisons for agricultural, horticultural or household use. Filed June 7, 1946, by American Cyanamid Co., New York.

Classified Advertising

Rates for classified advertisements are ten cents per word, $2.00 minimum, except those of individuals seeking employment, where the rate is five cents per word, $1.00 minimum. Address all replies to Classified Advertisements with Box Number, care of AGRICULTURAL CHEMICALS, 254 W. 31st St., New York 1. Closing date: 1st of month.

Wanted: By old-line chemical specialty manufacturer, established sales agencies covering two or three states each calling on jobbers, dealers, etc. to handle insecticides, disinfectants, farm and industrial paints, roof coatings, and other specialties. Agents to call on trade only. Restricted but exclusive territories. Change in sales policy. This line sold farm and industrial areas for fifty years. For further details, write to Box 173 care of Agricultural Chemicals.

Wanted: By a national manufacturer of insecticides, fungicides and weed killers, two salesmen, preferably with agricultural education or background. One to cover the New England states, the other to cover the North Central states. Excellent opportunity to expand substantial business. Straight salary plus actual travelling expense. Address Box 174 care of Agricultural Chemicals.

For Sale: Paris Green. One carload 100 pound drums, 20c pound. Chemical Service Corporation, 80 Beaver St., New York 5.

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Position Wanted: Plant Pathologist, M. Sc. 1943. Now employed. Experienced in technical sales service, contacts and research. Will travel widely. Address Box 176, care of Agricultural Chemicals.

Position Wanted: Entomologist — Ph.D. with 20 years practical experience in agricultural insecticides with government and industry open for new connection with agricultural chemical firm. For full details, communicate with Box 177, care of Agricultural Chemicals.

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Position Open — Sales Manager — Coordinator for southwestern manufacturer of economic poisons. Must know how to work with farmers, understand use of agricultural chemicals, spraying and fogging equipment. Packaged insecticide experience desirable. Ability to organize sales campaigns and follow through on service details absolutely essential. This can be key position in fast growing new organization with solid backing. Wire or write Box 178, care of Agricultural Chemicals.

Sales Position Open: Large chemical manufacturer has need for salesman to headquarter in a Southern City. Prefer one having experience in selling agricultural and industrial chemicals. Please give full particulars including references. Good future for man having executive and sales ability. Advise starting salary expected. Address Box 180 care of Agricultural Chemicals.

Sales Manager Wanted: For well established insecticide manufacturer. Location midwest. Must be experienced in selling manufacturing trade, handling salesmen, planning sales programs. Good salary for high grade executive. Send resume of training and experience to Box 179 care of Agricultural Chemicals.

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TALE ENDS

ADD to the growing list of new insecticides soon to appear on the market, the name "Tetraethyl Pyrophosphate" which is being manufactured in small quantities by Monsanto Chemical Co., and Victor Chemical Co. Little information is available regarding its characteristics and toxicity, but this should be forthcoming soon.

•

The *Farm Journal* recommends a way to stop Communism in the world. It says: "Instead of sending diplomats in striped pants, maybe the U. S. ought to send a few good County Agents and Future Farmers of America armed with equipment that won't explode. American agricultural know-how impresses us far more forcibly than our diplomatic know-how. The international conferences have not accomplished much. Perhaps a few Farmer's Institute and Farmers' Weeks overseas would do more for the cause of peace."

•

Germany's once gigantic nitrogen-fixing industry, which before the war produced some 700,000 tons of nitrogen, is expected to turn out less than half of that quantity this year. Where she formerly exported around 100,000 tons annually, this year an estimated 400,000 tons of nitrogen will be sent to Germany.

•

The state of New Jersey, in an attempt to determine the effect of air pollution on agriculture and ornamental vegetation, has authorized the state Experiment Station at New Brunswick to make a study of the problem. In many industrial areas, factories were releasing waste gases such as fluorine and chlorine, which have a retarding effect on vegetation. The station has worked out gas chambers in which plants are grown, and where the air can be "polluted" to simulate the atmosphere near industrial centers. It will be interesting to follow the progress of this study.

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OX-WARBLE FLY

(Hypoderma Pineatum)

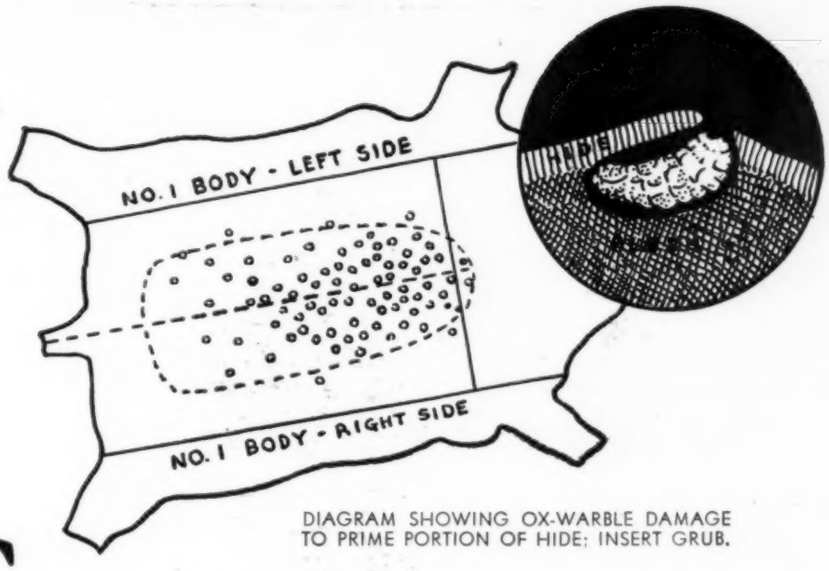

DIAGRAM SHOWING OX-WARBLE DAMAGE TO PRIME PORTION OF HIDE; INSERT GRUB.

BUG OF THE MONTH

...controlled with Rotenone

The loss from these insects—in terms of lowered vitality, reduced weight, low-grade beef and worthless hides—is estimated to be in excess of $100,000,000.* The heel fly and its relative, the bomb fly, have infested an estimated 75% of our cattle.

Eggs, laid on the hairs of heel and underbelly, develop into tiny larvae which tunnel into the animal and feed on its vital tissues for nine months, finally locating on the back. There the ½ to ¾ inch grubs cut breathing holes through the hide and spend the last 60 to 75 days maturing into ripe pupae.

The most effective treatment is a dust, spray or dip containing rotenone. Applied liberally as soon in the fall as the first lumps appear and every 30 days thereafter, it kills the larvae and permits the grub-holes to heal.

For such preparations, there is no better form of rotenone than Prentox Cubé Powder. Its exceptional quality has made Prentiss the largest producer of rotenone powders in the United States. Each batch, assayed for potency, is ground to uniform fineness, then screened to produce a completely fiber-free powder. Finally, it is blended to uniformity, and sold on the basis of guaranteed rotenone content.

For cubé or any agricultural insecticide concentrate, Prentiss' manufacturing facilities and technical knowledge are at your disposal. Your inquiries are invited.

*National Live Stock Loss Prevention Board.

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■ PYRETOX 100 is an impregnated pyrethrum dust base of 200 mesh fineness containing a minimum of 1% pyrethrins and mixes readily with any of the usual diluents though Pyrophyllites and talcs are preferable.

■ The advantages in effectiveness, stability, and economy of properly impregnated pyrethrum bases over pyrethrum powder have been too fully demonstrated over a period of years to require elaboration. One pound of PYRETOX 100 is roughly equivalent in effectiveness to two pounds of 1% pyrethrum powder and is much less expensive.

■ PYRETOX 100 is indicated wherever a pyrethrum dust is needed or whenever it is desired to step up the activity of DDT or other ingredients by the addition of pyrethrum.

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